THE FOUNDRY

VOL. 12. DETROIT, MICH., JULY, 1898. No. 71.

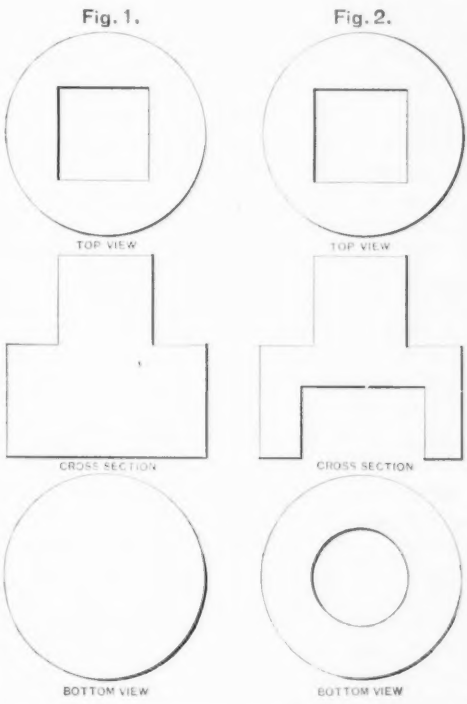
Melting, Mixing and Casting Brass.

BY JOHN A. MACAULEY.

In this article I intend to speak, only, of mixtures that are in use every day, and that are of practical value to the engineer.

However strange it may seem, it is nevertheless a fact, that molders in general know very little about mixing and casting brass.

We sometimes hear of a man who makes



the startling discovery that, by pouring hot, all the evils are eradicated and a good casting produced. To show the absurdity of this "hot" doctrine, let us see its effect on the very generally used mixtures of copper and tin.

The first thing we have to procure is Lake Superior refined copper. This is acknowledged by all to be the best casting copper. We will melt it. When the copper reaches the melting point, it is no more refined, except as to its purity from foreign substances, than it was when in the smelting furnace. To prove this let us take from the crucible a sample, in a small sample-ladle, about one one and one-half inches across the top and three-quarters of an inch deep. When our sample has set, we notice that it has a spongy appearance on the surface and has raised in a blister on one side, and we will probably find a hole at the other. Now all this is caused by the copper absorbing gases while melting, and the higher the temperature reached, the greater the absorption of gases, until it reaches a white boiling heat, when it is useless. Pour this into a mold of any kind and it will still retain these gases, as can be easily seen by breaking the casting and examining the fracture. And not only does the copper absorb gases, by this superfluous heat, but it is rendered very brittle.

We now have our charge at the melting point and have seen its condition when cooled. The next step is to reduce the gases found in it. Some men say that it may be done by mixing with tin. This will, to a certain extent, expel the gases and cause a more homogeneous fracture, but, in my experience, I have yet to see a casting of this mixture and made in this manner without a hole in it somewhere.

Instead of this process, we will refine our copper before adding the tin. To do this we will take a hardwood pole two or three inches in diameter, plunge it to the bottom of the crucible, and stir the copper slowly but steadily until a sample, taken from it, will show, on cooling, a small shrinkage hole, of a brownish color, in the center of the ladle. When it reaches this stage, we must not allow the temperature to rise, but to continue the stirring and in a few minutes another sample taken will cool with a level surface. By breaking this sample, we will find it to be of a close, fine grain.

We all have our peculiarities and so has copper. One of them is that continuing the stirring process for too long a time will

bring it back to the starting point. How this gas gets back, I will not attempt to explain, but, that it does get back, I know from experience to be a fact.

Now we have the copper refined and at the right temperature. We will add a liberal supply of powdered charcoal. If a copper casting is required we pour it now. If tin is to be added, we proceed by first plunging the tin well under the charcoal and stirring with a plumbago stirring rod. When thoroughly mixed our metal is ready for pouring. It is important that the charcoal be left on as it will keep the air from acting on the surface of the metal, and so, we will avoid that hard scum which very often gets in and which is, of course, injurious to the casting. A skimmer can be made to fit the crucible, over the lip, to keep the charcoal from running in.

Now we have our casting poured, but our troubles are not yet over. If the casting is heavy in parts, say three inches or more, and allowed to cool slowly, the copper, or, to be more precise, a combination of copper and tin but principally copper, will set first in large crystals, and the other combination, principally tin, will run around the larger crystals, causing what appears in fracture to be a separation. And I have noticed, in castings that have been poured very hot, this tin combination to have raised to the top of the casting and, sometimes, to the top of the riser. But, in the casting just poured, we have not had that superfluous heat to contend with, and we will strip our casting as soon as it is set hard enough to handle and plunge it into water (running water, if possible). The more quickly it is cooled, the more nearly our casting will be of equal strength throughout and the more complete will be the absence of separation. I have made bars of these copper and tin mixtures, eight inches in diameter and fourteen inches long, with the fracture showing not the least sign of separation.

Let us now consider combinations of the three metals, copper, tin, and zinc. These cover a wide range of usefulness, being used very generally by the engineer for steam-fittings, boiler plugs, etc. Brasses that have to stand steam pressure of from four hundred to five hundred pounds must be strong and close.

A very satisfactory formula in this series is copper 83⅓, tin 8⅓, zinc 8⅓. Rapid cooling increases the density of this very considerably. I saw some cylinder plugs, like Fig. 1, cast of a composition of two per cent less zinc and two per cent more copper than this formula, through which steam blew at a pressure of one hundred and fifty pounds. They were afterwards cored as in Fig. 2, and stood three hundred and twenty-five pounds pressure. This shows clearly the effect of more rapid cooling.

It is in these mixtures that we find little shrinkage holes at the gates and depressions of the surface. To try to remedy this by raising the temperature of the brass, is simply substituting a worse evil for the existing one. The little holes at the gate can be prevented, very often, by cutting the gate into a lighter part of the casting. By so doing, we have the hotter metal in the lighter parts, when the mold is full, thereby allowing the heavy parts to draw from the lighter, and the lighter to draw from the gate. When this fails, build the sprue up six or eight inches higher than any part of the casting, as the higher it is built, the greater will be the pressure on the casting. Wherever possible, gate a brass casting at the bottom and allow the metal to rise in the mold. If hot metal is required at the top, cut a branch gate there, but in such a way that the metal cannot run in until the mold is filled to a corresponding height. I will give some of the more useful formulas further on in this article.

. Too much care cannot be taken against getting any of these alloys too hot.

We will now take the copper and zinc mixtures. In coming to these we have an entire change of program. Instead of melting the copper first, the zinc is melted first and the copper added. Small quantities of tin are sometimes used in these. When this is so, it is added to the copper and zinc. The chief reason for this change of procedure is that zinc, owing to its chemical action on copper, will melt, while at its own melting point, nearly four per cent of its own weight of copper. Therefore, by melting the zinc first we can melt our charge at a little less than half the temperature required to melt the copper alone. So, in this way we save about six per cent of our zinc, which would be burned off by the increased temperature. This alloy needs no refining, as the zinc prevents absorption of gases by the copper.

Mixtures that come anywhere near to copper 70, zinc 30, are at the right tempera-

ture for pouring when the copper is melted. If we go beyond this heat, we will find that while the mold is being filled, white flakes from the zinc will rise to the top, leaving corresponding holes in the casting. It is always well to turn the molds on end, as this metal is of such a spongy nature that it requires pressure to give it the needed density.

We find some of our strong alloys in this family. I made a casting of copper 62, zinc 37, tin 1, to take the place of a steel casting which stood eighteen months. The brass one has been doing its duty for nearly four years, with no signs of going to the scrap pile.

In casting any of these alloys the mold should be faced with plumbago or some other anti-friction substance.

The following are some formulas that have proved valuable in my experience:

For bearings: Copper 84, tin 16, or copper 84, tin 14, zinc 2.

For axle bearings: Copper 80, tin 18, zinc 2.

For bearings for small pin with heavy friction: Copper 83, tin 15, zinc 2.

For piston rings: Copper 89½, tin 10½.

For heavy piston rings: Copper 82, tin 18.

For piston rings for locomotives: Copper 88, tin 10, zinc 2; or copper 89, tin 2, zinc 9.

For locomotive whistles: Copper 82, tin 16, zinc 2.

For crank keys: Copper 85, tin 15.

For piston rods: Copper 88, tin 12.

For stuffing boxes: Copper 90¾, zinc 6¼, tin 3½.

For bell metal: Copper 78-80, tin 22-20.

For a good metal for casting upon iron: Copper 78¾, tin 6¼, zinc 15.

For a strong and close brass: Copper 83 1-3, tin 8 1-3, zinc 8 1-3.

For gear (small): Copper 84, tin 12, zinc 4.

For gear (large): Copper 89, tin 8½, zinc 2½.

For hand-rail knobs: Copper 70, zinc 30.

For pump-bushings: Copper 62, zinc 37, tin 1.

Feeding Rolls.

By R. D. MOORE.

I have been claiming, in a former article, that one feeder on a casting is perfection, that if we add more the feeding power is reduced in proportion to the increase of the number added. A roll presents a form of casting making it impossible to use more than one feeder, but furnishes a casting very difficult to feed perfectly sound; in fact, it probably never was accomplished in rolls having a body large in proportion to the necks through which the feed iron must pass.

The writer once, years ago, had a three years' experience on a "dry sand" floor, a considerable part of the time casting rolls, and realizing the great importance of sound necks, devoted much thought on its accomplishment during that time. A plain roll body is one of the most compact bodies of iron found in the ordinary molder's experience. The surface inches being very small—and that is what really regulates the time required to cool off a body—a roll requires a very long feed, and it must be fed through a greatly reduced neck, and a still smaller coupling.

Fig. 1

The round, three-groved, modern roll coupling gives a much better feeding opportunity than the four-winged coupling entirely used in former years, which presented a very small area at the only feeding point.

The writer, "on the sly," tried several experiments in roll feeding, in the interest of sound necks, and, I believe, always successful, as I never heard of any break, although keeping close watch.

My first experiment was, after feeding through the heat, lifting the flask out of the pit and lowering the top end of flask on blocking set high enough to give the position shown in Fig. 1, the dotted line AA showing a horizontal line, the object being to place the shrink hole at the point shown at dotted cavity B, the strongest part of a roll, where in fact they never break, and securing a sound neck, that part being below the shrink cavity, if one should occur.

My impression is that this is one of the best treatments in securing a sound neck, but overhearing much grumbling among the labor gang about being kept an extra half

hour after a big heat on that job, I abandoned that practice for an easier one for them.

I adopted a smaller feeder, feeding until the churning rod felt a stiffness in the metal about the coupling and reduced feeder, then removing the churning rod, inserting a cold cast iron rod, moving it slowly up and down

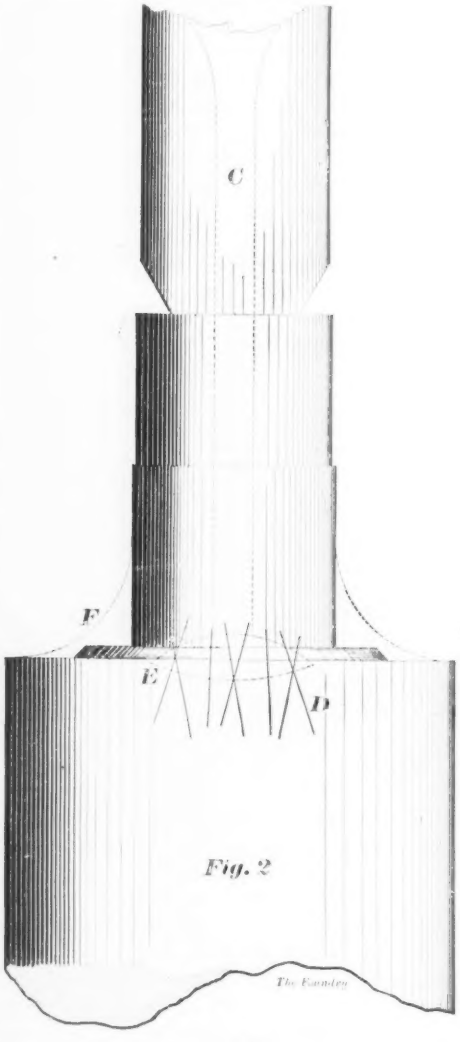


Fig. 2

until it accumulated a thick crust of iron around it, then removing it inserted another in that manner, until a smooth hole was formed about two inches diameter, shown at C, Fig. 2, and reaching down to the soft half fluid metal.

At this point in the feed much care is required, the two-inch hole will begin to widen as it reaches a few inches into the casting where the iron is hotter, when a little hot iron should be added to close the spreading hole to two inches.

A very small rod should be kept in the hole to feel the crust that may form, say every ten or fifteen minutes, after the hole gets some depth.

Spittle, dropped in, has a wonderful effect in improving the sight at the bottom of the hole, the uniformity of the color making sight very difficult when watching the shape alterations, or widening, two or three feet down.

When a crust forms on the surface, a cast rod should be used to keep the hole in shape as before, continuing this process to the bottom of the neck if the feed iron can be continued so long; the hot iron will easily weld on to the surrounding hot metal.

As the hole approaches the bottom of the neck the tendency to widen will increase, and it will need a small feed applied often.

I adopted this system of roll feeding and continued it for years, or as long as I was connected with roll making, mainly because it admitted an extension of the feed for hours, or longer than melted iron can generally be supplied after a heat, and much longer than any churning process can be continued, besides giving promise of a much better casting, and, I might add, a large saving of labor over a hot casting.

When a roll body was extra heavy, or the time of hot iron supply very short, I adopted another trick, in connection with this system of feeding, to secure a sound neck. I prepared beforehand a dozen cast-iron rods, say three-quarters inch square, broken into one-foot lengths, well cleaned in the tumbler, and warmed to insure dryness, and at the end of the feed iron supply dropped them one at a time into the hole, and with a light rod, previously prepared and tried, with a curved end, pushed the cast rods aside, thus distributing them as shown by heavy lines at D, Fig. 2.

It is reasonable to infer that a cluster of cold rods in that position would chill the metal sufficiently to prevent a shrink hole at the damaging point shown at dotted lines E, Fig. 2, and move the probable cavity lower down or away from the neck.

During my roll molding period a pattern was dropped on my floor with great fillet collars added, as shown at F, Fig 2. I was mad, felt outraged; one of the proprietors, a very sensible old molder, coming along, I

kicked, told him I would not promise a good neck; that it was unreasonable to expect a sound neck from such a pattern, the suggestion of a roll turner, probably. That proprietor pretended to laugh at my suggestion, walked around the shop, ground some more tobacco and, going out, on passing my floor, said: "Moore, you can knock that fillet collar off if you want to," and I did, and burned them

That boss was evidently converted to my view of the case. I called that a gigantic blunder, throwing away the most valuable metal at the neck, the outside shell being the only reliable stock that we are sure of.

We will suppose a shrink cavity occurs as shown by dotted lines at E, leaving about three inches of good shell; if we add that three-inch fillet, F, Fig. 2, we will certainly cause that cavity to spread at least that amount under the same length of feed; what then have we left after that three inches of sound metal is turned off? Principally a shrink hole at that cardinal point.

That cavity or shrink hole at E may be an exaggeration, but when we compare the long, slender neck with the great body, lying in the centre of casting, and the comparatively short time a churning rod can be kept moving, it certainly looks reasonable as a possibility.

Something About Foundry Office Work—Raw Material Account.

By A FOUNDRY CLERK.

While it is the custom with some foundries to buy raw material in large lots once or twice in a year, there are other foundries who do their buying in small quantities at any time, according to the demand. In making out a monthly report, no other item is so difficult as the raw material item to get at. A monthly inventory, or the hiring of a storekeeper are both expensive experiments, but when a monthly report system should be adopted, the control of raw material used during the month is necessary. I have in practical life found three different ways to make use of; one is independent of the other, so it depends on conditions which way to use. The three ways which I can recommend are the following:

1. A simple and sure way of keeping track of what is taken from stock piles.

2. A simple and sure way to estimate on a basis of statistic data.

3. A way to do monthly buying and equalize the same.

When I first introduced the way given under No. 1, I ordered about two dozen common slates with pencils; next I had boxes made 12x12x12 for measuring sand, also boxes to hold a certain amount of coke; in short, I had measures for all kinds and for all purposes, and scale facility as near as possible to certain piles of raw material, some of the slates I hung up in the different sheds, and some I placed in the hands of proper workmen. With the good will and the consent of the foreman, I had everything arranged at the end of the year, so I began at the first working day of the year to instruct everybody concerned how to mark down what was taken from stock piles. After a little watching for a day or two, the thing went on fine. The first day of February, in the morning, I went around and took the count, afterwards I filled out a sheet of raw material used. It is not so very hard to find out what the raw material thus marked down is worth, and if we do run a little ahead or behind, the year's inventory will show this, the December sheet will allow an equalization. The result of my experiment on the end of the year came to more than what I had expected; it showed me another good way, the way No. 2. After I had twelve monthly sheets of raw material I went and added up each kind by itself, and by using the year's product as a basis, I secured statistic data on raw material as good as could be obtained. In a foundry which does nearly the same work all year around, the raw material used can be easily found by the month's product. Again I found the way No. 3 when I noticed that the foreman used my statistic data for introducing a system of monthly buying; so it came that whatever was bought within a month was charged to the foundry for the month, and the account given to the foundry clerk. In the course of time I found that the foreman used very good judgment in equalizing the buying, so, for instance, when it became necessary in November to lay in the winter's supply for sand, we were well supplied with other material, so we had to buy but little of this other material. Again, when it came to buy a carload of facing, the same course was followed. The twelve monthly slips showed everything bought within one year, a good

inventory at the end of the year showed the amount on hand, and this compared with the inventory from the year before, enabled us to find exact figures, so we could equalize the account in the month of December.

The way No. 3, as I may call it here, is the most practical one, in order to secure an accurate account for raw material. The practical man no doubt will admit, that estimation is a good thing, in order to save expenses, but estimation should never come down to a mere guess, whatever is done in this line must come as near as possible to the truth. There may be other good ways to control the use of raw material, of which I do not know, but what I claim to know is with good success practically tested, so I may say, try it.

Feeding Castings.

By R. D MOORE.

Having returned very late in May from a four months' visit in Florida, I read the remarkable criticism on my article in the April FOUNDRY, under the above heading, too late to reply in the June issue.

A French stage dancer astonished all Europe, many years ago, by placing 100 eggs on the stage, and, after being blindfolded, performed a fancy dance among them without touching an egg. Mr. Ramp has exhibited a skill fully equal by shuffling through a half column of criticism without in the slightest degree touching one point made in that article.

For instance, he charges me with condemning the twelve or more inches of highth of the cut-off ring, or feeder, on cylinders, etc., when there is not a word, or hint, in that direction.—See April FOUNDRY.

I condemned the horizontal not the vertical extension, the one shown being five and one-half inches thick and 240 inches wide, and holding over 35,000 pounds of iron and which, if partitioned off, would make 20 heads, 12 inches wide.

I, as plainly as I could, claimed that 19 of these heads were a damage to the one I adopted, and which done the feeding on that three years' contract so perfectly.

Again, this feeder is shown three inches higher than the condemned feeder, the thickness of a loamed brick; does that look like condemning the highth?

I introduced a square shaft also to show up this wrong theory and practice. An old molder who had made many cast shafts for western steamboats, which admitted of only one feeder, showed that he was under the same delusion as our critic, and itching all these years to get more feeders on those shafts, put six on a square shaft cast horizontal, committing the same error as in the valve chamber under discussion, and getting the same results, six great shrink holes. Mr. Ramp complains that there is a great difference between the valve chamber and the shaft; the principal one apparent being that one had 20 feeders and 12 shrink holes, the other six feeders and six shrink holes, all that could occur; with 20 feeders on the shaft, no doubt 20 shrink holes would have appeared. A strong point of resemblance is often found in articles very different in their general features; for instance, a boiled lobster and a sunrise are both red.

I cannot see why a shaft fed with five surplus heads is not lost on the same principle as the valve chamber fed with an excess of 19 heads, when the results are, in both cases, equally disastrous.

The Molder of the Future.*

By P. W. GATES.

The subject "The Molder of the Future and the Need of an Adequate Apprenticeship System" is one which has been given much thought. In making these remarks I do not pretend to do more than offer a few suggestions, which I hope will bring out a full discussion, and thereby give us the thoughts of members who have given this matter a great deal of study, from which it may be possible to organize an apprenticeship system which may be something like uniform throughout the States, and tend to raise up a class of molders of intelligence, calculated to meet the demands of a rapidly growing industry.

If we are to draw our conclusions of the molder of the future by comparing the molders of the present with those of the past, it becomes evident to me that steps must be taken to induce young men to embrace this trade of sufficient education to readily grasp it on different lines from those followed in the past twenty years. Otherwise the business will suffer to such an extent as to make manufacturers untold trouble. That we

*Read at the Cincinnati meeting of the American Foundrymen's Association.

had better molders in the past than at present is accounted for in the fact that foundries as a rule were smaller and did a more general class of work, it often being the case that foundries employing not more than ten or twelve molders would manufacture plows, stoves, printing presses, water wheels, steam engines, both stationary and marine, saw and grist mill machinery, reapers, mowers, threshing machines, etc. The young man who was fortunate enough to serve an apprenticeship in such a place certainly gained a general knowledge that stood him well in hand wherever he went. But the growth of this business in America has been so rapid that it has brought about the specializing of the different branches, and in doing this at

P. W. GATES.

once destroyed the opportunity of making the same high grade mechanics as was turned out in the general foundries. This specializing is carried to such an extent that in hiring a molder now it becomes necessary to ask him what line of work he is accustomed to; while in the past the bare statement that the applicant was a molder carried with it that he could make any class of work. I have heard it argued that specializing must continue until finally there will be shops making nothing but cylinders, others making nothing but engine frames, others nothing but fly wheels, and that it will not be necessary to have apprentices, as common laboring men can soon be schooled to make any one piece cheaper and to greater perfection. I cannot take this view, but believe the general foundry will always occupy the largest place, at least in number, and to my mind the molder of the future must be different from his prototype. He must have a good education to begin with, so as to be able to study properly the material he is using. In the future pig iron will be known by its properties; so with sand and all other material the molder uses. Hence the ignorant boy who formerly made a fairly good molder will have no place in the strictly modern foundry of the future.

Speaking now of apprentices in general, for all branches are equally affected, I think it will be conceded without much argument that the more intelligent a class of mechanics becomes, the higher the standard of the work which they produce, and the higher the moral tone and self-respect of such class. It seems to me necessary for the foundrymen and manufacturers generally throughout the country to encourage and employ apprentices, for the sake of supplying the places of journeymen who fall out of the ranks through sickness, death, etc., and to supply the necessary molders for new industries. It therefore seems desirable to me that young men of education be induced to seek this vocation as a means of livelihood.

If this is the fact, the question then arises as to how we may secure such apprentices. The experience in our works has been that it is very difficult to induce young men who have passed the grammar schools, or schools of equal or higher standard, to embark in the molder's or other trades. There seems to be no difficulty in getting plenty of applicants of an uneducated class, but our appli- perience in the past has been that this class are not willing to submit to the necessary discipline, and if they are, they are usually dull and slow to learn. On the other hand, we have found that where we could get applicants who had been through the grammar schools, or other equally good schools, they appreciated the fact that discipline must be enforced, were always willing to live up to the rules, were anxious to advance themselves, and were students in their new vocation, as well as they must have been at school, in order to have passed through it. Having acquired the habit of study, we find that they apply the same thought to their work, can readily grasp the instruc-

tions given by the foreman, and are not satisfied with merely getting through with their work as a stint. On the other hand, they study the conditions and take great pride in the character of work which they are turning out. From this experience, we have reached the conclusion that we shall try to confine ourselves to a class of apprentices who have at least reached as high a standing as to pass the sixth grade in the public grammar schools, and, if possible, who have graduated from the grammar school or some school of equal standing with the public schools of our city.

In casting about for the reason why we do not have applicants from this class of young men for apprenticeship we reach the conclusion that the inducements offered are too small, and therefore decided to offer a better scale of wages and inducements, for several reasons. First, in many instances the parents of would-be applicants of this kind are mechanics who have had a great struggle to give their children the benefit of a grammar school education, and who, having other children coming along who are gradually absorbing more of their means, feel that as soon as the boy has passed the public school, he should be in condition to be self-supporting, and cannot therefore afford to contribute much if any toward the support of the boy for a further term of two or three years while he is passing through the earlier stages of his apprenticeship. On the other hand, it is natural, and in one sense creditable to the boy, that he should wish to be self-supporting, and also only natural that he should desire to earn enough so that he may have some small amount of spending money. These desires, we think, often blind the boy, and perhaps the parent as well, to the fact of the reward when the apprenticeship is done, and the possibility that the boy may find some employment which will earn him something like $1 or even $1.50 a day at once, although it may be nearly as high an amount of wages as he will ever reach, decides him to go in this direction.

I know a number of young men who attended public school with me when a boy who are to-day in positions such as street car drivers, conductors, teamsters, etc., who I remember as bright boys in their studies. Some of them have told me that the mistake of their life was in not having learned a trade, and I feel sure some at least would have been able to have earned much more money than they are now earning, and perhaps been high in the offices of some good institution, had they learned a trade thoroughly.

I am sometimes inclined to agree with a friend who once asserted that no one ever learns anything from experience. Be that as it may, young people are slow to profit by the experience of others, and since the fact remains that we do not seem to get many applications from desirable apprentices, we set the foregoing reasons down as being responsible for the fact, and adopted the following standard:

We refuse to take any applicant who is not to appearances physically sound, cannot bring good recommendations as to character, has not passed through the public schools at least as far as the sixth grade, or of some equivalent educational institution, and is willing to serve three months on trial before signing articles for a four-years' apprenticeship; the three months of trial, however, being counted as so much time on the first year.

A year is to consist of 300 days of 10 hours each, and for

The first year we pay 7½ cents per hour, or $4.50 per week.

The second year we pay 10 cents per hour, or $6.00 per week.

The third year we pay 12½ cents per hour, or $7.50 per week.

The fourth year we pay 15 cents per hour, of $9.00 per week.

The week consists of 60 hours, and it is our policy to give the apprentices full weeks, even if the machinery is not running, by placing them at such times on work that can be done without the use of power.

This scale of wages was made with the idea that it would be nearly if not quite the equivalent that any would-be applicant would be offered if he were going out to find work of a general character, and would therefore be attractive to applicants. We offer a further inducement in the fact that we agree to give each apprentice at the end of his apprenticeship the sum of $100 as a bonus for the faithful performance of the contract entered into between us. We are of an opinion that from an economic standpoint we might do better with journeymen at journeymen's wages, but we also believe that it is a duty which we owe to ourselves, and to the manufacturing fraternity to keep

up an apprenticeship system which will develop good journeymen, and we feel that if we do this, and other manufacturers do it, we shall be able to supply ourselves in the future with mechanics of such class as will be better qualified for the work demanded of them, and in this manner be indirectly repaid for the outlay.

We require of our apprentices that they attend night drawing schools so that they may become competent to make ordinary sketches, and help them to learn how to read drawings, and it is our policy to interest ourselves in these matters to a large extent in order to encourage the boys in the greatest degree. I am pleased to say that we always find the class of apprentices of which I have been speaking not only willing, but anxious to avail themselves of such facilities, and that the foremen take great interest in such cases and are always willing to help the good work along.

Not only has our experience with apprentices who have passed the grade of public schools been satisfactory, but in instances where we have had apprentices who are graduates of the technical or training schools, we have found their progress rapid and their ability equally greater, and for this reason we place such graduates in a separate class, offering them apprenticeship positions which omit the first year's work, and starts them on the second year. We feel that we can do this for two reasons: namely, they have, through the practice received at the training schools, acquired some ability, which lessens the amount of attention they need from the foreman; second, a superior educational training and discipline incident thereto fit them to progress faster and accomplish the same results, or better, in the shorter time. The Western Foundrymen's Association adopted a form of agreement for apprentices in which some such distinction was made, but for some reason it has never been put into active operation by the members.

It seems very essential to me that the apprenticeship matter should be given careful consideration by this association if we have any regard for the molder of the future, and that it should be the duty of every manufacturer to increase his apprentices to the fullest extent consistent with circumstances. In our machine shop we employ 14 apprentices, in our millwright shop one, our pattern shop one, and in our foundry 10. And it is our policy immediately to put in a new apprentice as often as an old one drops out, for the reason that we advise all our apprentices as soon as their time is out not to remain in our shop, but to go out and get the benefit of experience from other shops, believing that sooner or later more or less of them will return to us more efficient workmen than ever.

There is one other matter which I might with propriety call to your attention in this paper: namely, the advisability of co-operating with the training schools in the conduct of their work shops. In talking with the principal of the Lewis Institute of the city of Chicago, on this matter, I asked him whether it would be of advantage to him if a committee from the different branches of manufacturing would call at the institute, say once a month, and inspect the work going on in the shops, and offer such suggestions as would seem to make the work practicable and available for use in such manufactories when the students were out of school. He informed me that he should hail such an arrangement with delight, and that it would be of the greatest benefit to both the faculty and scholars. It seems to me, therefore, in such light, that it is the duty of associations to take up such matters, as committees of this kind, drafted out of members of associations, would not entail a hardship on any manufacturer, would cause regular attendance and would be of the greatest benefit to all concerned. It is possible that such matters had better be left to the local organizations throughout the country, but as most of the members of this association are members of some local organization it may not be amiss to mention the matter here.

Adding Steel to Molten Iron.

By R. H. PALMER.

In the June FOUNDRY I see Smith & Co. would like to hear something regarding mixing and melting steel with iron. Perhaps the following experiments will interest them:

While foreman of a foundry making heavy engine work, using Allentown plain, Crane 2x, Powelton 2x, Granger 2 plain, I drew a ladle of iron two-thirds full at a white heat from the cupola, and poured a test bar 1 inch square. I then added to the iron remaining in the ladle, steel shavings,

a handfull at a time, until I had added as near as I could get it about 10 per cent. I then cast a test bar from the same pattern as the first. The iron alone broke at 2,413 pounds, the iron and steel at 3,273 pounds, poured into a set of jim cranks. They took a splendid finish, the steel giving the iron a very fine grain, yet working evenly and nicely in planing and boring.

Again, at another foundry, having some hydraulic rams to make for tobacco presses, weighing from 1,600 to 1,800 each, the thickness of side being some 2½ or 3 inches, and they were to be rejected if they sweat under pressure. I took a ladle holding about 2,400, and put under the spout of cupola, and when I had some 300 pounds of iron in it, commenced to add steel shaving until out of 2,100 in the ladle I had about 170 pounds of steel turnings. The steel in both cases was from low-steel shafting. The casting stood the test, and I made more for the same firm. They, as I remember, had been paying 4 cents a pound for them cast from iron from air furnace. I made them for 3 cents, and as a man and helper made one a day in green sand, you can judge it paid well. Again, I have used the above in gears weighing 600 or 800, where an extra amount of strength was wanted, always with good results.

Remember to stir the metal well with skimmer while adding the steel.

In corresponding with one gentleman and mentioning mixing steel in the above manner, he said in his reply: "We at one time made a quantity of spike dies and did not get successful results until we melted with our iron some Bessemer steel rails."

Now, as an experiment, and to me a very pleasing one, outside of its usefulness, was to note the changes in the color of the metal as it passed through its different stages of heat, and I should term it of chemical composition as well.

Taking the iron at a white heat, it does not at first seem to want the steel, but when it commences to take hold, and then as it gets a little, it seems to want more, passing from a white heat to flesh color; then it is eating fast, then to a pale straw, eating fast; then a rich golden yellow; now look out, if you keep adding, you will find it does not seem to absorb it. It collects on the top of the iron, in sort of spongy masses, and you will have to stop.

To me it seems to have taken all it can handle. It has not heat enough to handle more, and it seems as though it had taken all that would be of advantage to it.

It has now come to a point where, if iron were alone, we should say it was too slack, too cold, would not run out of ladle. Yet take this iron, and steel, and you find you can run quite a thin piece with it.

Its flowing or running properties seem to be increased, by the addition of the steel. Now my experience is in using the above kind of steel in connection with the iron, that it closes the grain making; a very fine grained iron; yet, although toughening, it does not harden; remember, I do not say all grades of steel will not harden, I say the kind of steel I have used has had no hardening effect that I have seen, and taking pieces of the test bars poured with it into a machine shop, and having an opinion given by those who had not used castings made of it, but were simply asked to give their opinion on it as a piece of cast iron, they have all given the same answer. That it was good and soft, and in one case one man picked it out as softer than the iron was originally, and that was:

Silver Gray, 500.
Ivanhoe No. 1, 600.
Crozier 2x, 800.
Woodward 2x, 800.
Mabel 2x, 200.
Mixed Silver G. and 2x, 400.
Scrap, 1,700.

I have been told of a foundry near Pittsburg that makes a practice of melting some steel in their cupola with their iron for certain machinery castings.

I have found the more steel I could add the stronger iron I have obtained from an iron breaking at some 2,300 and by adding steel 3,675, that is the highest and best. The poorest record was an iron breaking at 2,400, the iron and steel at 2,800. Most of the tests where the iron broke at 2,250 to 2,350, the iron and steel would go from 2,950 up to 3,300 or 3,400. These breaking tests were all made on a Reihle testing machine.

Advance of Chemistry.

By THOMAS D. WEST.

This article is written in answer to the editorial "As We See It," found in the June number of THE FOUNDRY.

The first item which the writer notes is that which states, "In their anxiety to create the impression that conditions existing in the foundry are unbearable, some persons ignore the fact entirely that the ordinary mixtures of cast iron used for making gray iron castings may be regulated through another medium besides chemistry, namely, through a physical test by the measuring of shrinkage," or, properly, contraction.

Regulating mixtures by the rate of contraction found with test bars is nearly as old as founding itself and is a practice that savors of "locking the stable after the horse is stolen." Regulating mixtures by means of test bars cannot be done until after a "heat" has been made. In cases where a founder can carry a large pile of iron that has been stored so as to be thoroughly mixed after the plan described by Dr. R. Moldenke in THE FOUNDRY of January, 1898, (a good system not one of a hundred foundries are in any position to adopt), the contraction of test bars may be made a guide to regulate the balance of that pile in mixture with itself or scrap, but it is to be remembered that in following such a practice chances are to be taken of the first or trial "heat" being productive of ill-suited or bad castings, whereas had analysis been employed the founder could have regulated the first as well as all subsequent "heats." Of course a small test cupola might be employed to test the iron before such would be charged in the regular cupola, but few shops have such, and at best such practices, now that we have analyses that can be employed to better serve these ends, would be unwise in the light of our modern advancement.

When we stop to consider that about 99 out of every 100 foundries cannot take their iron from one large pile, but must use it after a manner that may be said to necessitate taking a new pile every day or "heat," we then find conditions prevailing that make it ridiculous to think of relying wholly on the contraction of test bars, when we have the more modern method "analysis" to which we can resort to define what our iron was before being charged.

Carrying this subject still further and to a point that I know of none having discussed, I would ask the question, Is not most every casting that each "heat" makes, more or less a test bar within itself to denote what has been derived from a mixture. Then again, are there not light workshops using test bars at the present day that if they will but stop to seriously consider the real utility of their test bar practice, will be forced to admit that the test of chipping, filing, grinding, pickling and tumbling of their castings, will tell them as much and often a great deal more than their test bars, if their mixture was right or not. Is it not true that it is really what service our castings will render, or the ease with which they can be machined, filed or ground, that most founders take note of in preference to what the test bar may show them in defining if a change is necessary in making mixtures for their next or subsequent "heat."

Are not the castings themselves the thing we first observe to learn if our mixture has been right? As a rule, do not all founders upon entering their shops in the morning look at their castings before they handle their test bars? Is there any founder to be found that never examined his castings or solicited information as to their nature in preference to wholly staying in the testing room among test bars? I guess not. All labor, first to get their castings where they can examine or test them by actual usage, then having attained the perfection in them desired, the test bar comes in as a secondary factor to record results of mixtures that may be used for distant future reference to show in connection with analyses what combination of brands and metalloids are desirable to duplicate past results.

To advocate the use of test bars to wholly guide the making of mixtures to obtain desired results when we have such an improvement as analysis to define what an iron is before being charged into a cupola, is nearly as absurd as it would be for anyone to advocate abolishing all improvements that have been made in the design and equipment of our modern foundries. There is a good deal of humbug preached to-day in regard to the utility of test bars and the sooner this is exposed the better for the true advancement of founding.

The second point the writer wishes to discuss is the statement, "While we are aware that many founders, notably malleable and steel works, have obtained an additional profit through the aid received from chemistry, it does not appear to us that the universal instituting of chemistry should for that reason be expected to produce the same result in every foundry."

If, instead of stopping at this point, the editorial had produced some evidence to

demonstrate the truth of such a statement, I think it would have been much more satisfactory to all. The publishing of such generalities prove nothing. I claim that the idea advanced by the above, or, in other words, that analysis may insure desired results in one foundry but cannot do so in another, is impossible of proof, and that there is just as much sense in saying that blast blown in a cupola would melt iron in one shop but would not do so in another. The logic expressed, belittling the utility of analysis, is not to be wondered at. Steel work and blast furnaces have both had to pass through similar abuses. It is not many years back that the thought of using chemistry to guide or regulate mixtures of ores was ridiculed just as some are now doing with its application to founding. Where is there a blast furnace to-day that would think of running without having a laboratory to analyze all its ores, fluxes and fuels? I desire this article to put me on record as stating that the day is not far distant when all steady buyers of castings would no more think of patronizing a founder that did not recognize and use analysis in making his mixtures of iron than they would think of using a dark paint to obtain a light color on their machinery.

The utility of the test bar can never be increased to alone insure us obtaining desired results in making mixtures of iron, but analysis can, and to-day, if the experienced founder possess a correct analysis of his fuel and iron with all furnaces, "casts" well mixed, he can day in and day out obtain to an extreme nicety, just what he wants in his mixture's product. Further, unless the founder gives such assurance to his foreman or melter, I also wish to go on record as saying that the proprietor or manager is doing an injustice to his assistants if he holds them responsible for results of their mixtures.

THE GREATEST YET.

The Cincinnati Convention of the American Foundrymen.

If a greater assemblage and increased interest in the topics discussed at the yearly meeting of the American Foundrymen's Association may be taken as a criterion, the zenith of usefulness has not yet been reached by this body of representative American foundrymen. The meeting which closed in Cincinnati on June 10 was in every way superior to any of its predecessors, in attendance as well as in the activity manifested in the welfare of the Association.

As previously announced, the first day was largely given over to the registration of delegates, although the entertainment committee, headed by D. B. Meacham, began to show its liberality early in the day by giving a trolley ride to the early arrivals to Chester Park. In the evening those who felt no fatigue from their more or less extended journey, were rounded up and put aboard the steamer "Island Queen" and given a river ride to one of Cincinnati's pleasure resorts, known as Coney Island and initiated into the good grace of New York's namesake. The warm weather which prevailed nearly throughout the whole session made these side trips the more acceptable.

The first session was called to order on the morning of June the 8th at 10 o'clock by President Francis Schumann, with about 200 members and guests in attendance. As in previous years, the visitors were furnished with a numbered badge, though a distinction was made this year in that members were furnished with badges on which the word "Member" appeared, while badges given to those not affiliated with the Association bore the word "Guest."

After calling the meeting to order, President Schumann introduced Mr. Daniel McLaren, president of the Addyston Pipe & Steel Co., and chairman of the general committee of arrangements. Mr. McLaren extended a hearty welcome to the delegates and expressed the hope that their stay in Cincinnati would prove of profit as well as pleasure.

E. P. Wilson, secretary of the general local committee, was the next speaker. He expressed his regrets that official business prevented Mayor Tafel from being present, but gave assurance that any foundryman who should happen to be overcome by heat or other affliction would be taken care of.

Mr. James Bowron, first vice-president of the Tennessee Coal, Iron and Railroad Co., of Birmingham, Ala., was next introduced. Mr. Bowron is an accomplished orator and his discourse upon the Southern iron interests brought repeated applause. Although born an Englishman, and raised in the very shade of the famous Middleborough

district, whose furnaces at one time were thought capable of forever holding the palm for cheap pig iron production, yet he considered that his twenty-one years' stay in this country had entitled him to be called an American. The fame which the Middleborough district once held had been transferred to the Alabama iron furnaces and this largely through the activity of the Tennessee Coal, Iron and Railroad Co. To illustrate the wonderful resources of the Southern iron field, Mr. Bowron said that although his company had largely been working upon one vein of ore for the past ten years, yet they had in fact but just started, as he felt confident that even at the present rate of production 400 years would be required to exhaust this one lead.

Messrs. Lazard Kahn and D. B. Meacham, on behalf of the local reception and entertainment committees, added a few words of welcome, to which President Schumann responded on behalf of the American Foundrymen's Association. He referred to the vast amount of educational work which it had accomplished since its inception, and outlined future plans which it would be within its scope to take up.

After accepting the report of the secretary and treasurer, and providing for a committee on nominations and another on the revision of the constitution and by-laws, the convention adjourned until 2 p. m.

WEDNESDAY AFTERNOON SESSION.

The first paper read at the meeting was by Mr. P. W. Gates, of the Gates Iron Works, Chicago, who chose for his topic, "The molder of the future and the need of an adequate apprenticeship system." This and other papers read at the meeting will be published in THE FOUNDRY as space will permit. This year all of the papers had been printed beforehand, and copies distributed to the members, thus greatly facilitating the transaction of business.

Dr. Richard Moldenke followed with a paper on "The adoption of a standard system of test bars for cast iron." On motion of Mr. Switzer, the chair was authorized to appoint a committee with a view of securing a standard for test bars, a report to be made by the committee at the next annual meeting.

Thos. D. West's paper on the "Necessity of well mixed furnace casts and correct reports of analysis" was next read and brought out a short discussion.

"A talk on brass founding" was read by the secretary in the absence of the author, Mr. Chas. Vickers.

The paper by Chas. A. Bauer, entitled "A test for determining the hardness of cast iron," was in his absence presented by his son, C. L. Bauer, who replied to several inquiries concerning the operation of the apparatus.

THE SMOKER.

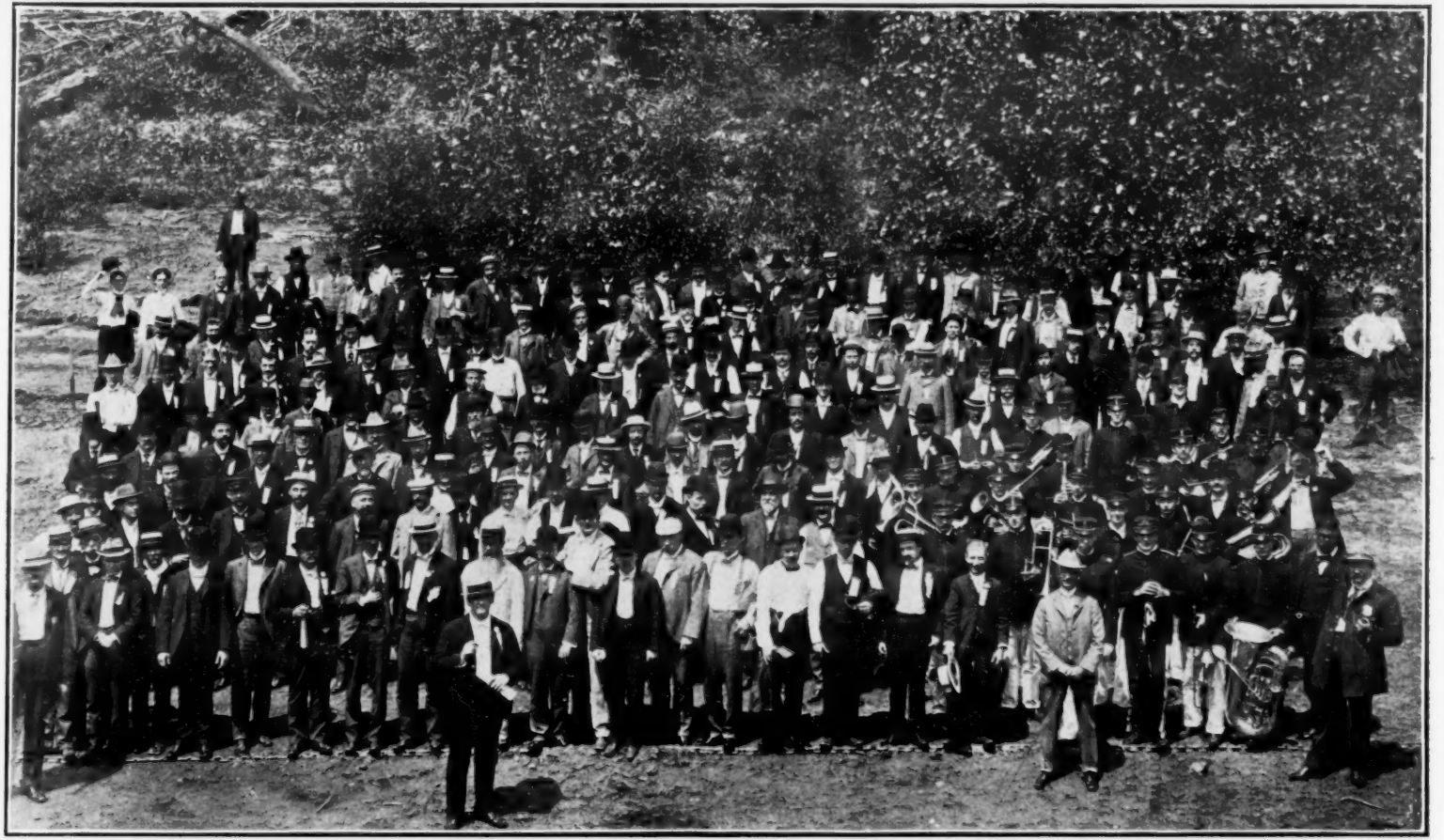
The entertainment committee provided a couple of hours' informal amusement Wednesday evening in the shape of a smoker. A genuine Missouri meerschaum pipe, together with a two-ounce package of tobacco and a small case of cigars, was handed to each one as he entered the hall, and the way the majority made use of the corn cobs would cause one to think that they had not all been raised on the sunny side of Easy street.

After those present had become comfortably grouped through half an hour's general conversation, they were treated to a vaudeville show, consisting of songs, dances, contortion acts, etc. At the conclusion of this feature a luncheon was served and impromptu speeches made by Messrs. Green, Sercomb, Cope and others.

One incident of the evening's entertainment is worth more than a passing notice. The laughter provoked by the witticisms of Mr. Sercomb and others had not died away when Mr. James R. Bowron stepped upon the platform, and complimenting the decorator upon the profusion of American flags in the hall, he touchingly referred to the absence of the colors representing "our brothers across the sea." The "three cheers for old England" which followed should have been enough to convince anyone that although the two great English-speaking nations are rivals for all that the earth holds, yet if appealed to in the right spirit they are nothing if not brothers. Mr. Bowron's remarks upon the future possible alliance between the two countries and his reference to American achievements in peace and war brought such a liberal applause that the speaker must have felt that he had touched upon a popular chord.

THE TRIP TO ADDYSTON.

Accompanied by the Chamber of Commerce band, the foundrymen and their friends left the Grand Hotel at 9 o'clock Thursday morning and boarded the steam-



A Group of Foundrymen as They Appeared Upon the Banks of the Ohio River on Their Visit to the Works of the Addyston Pipe and Steel Co.

Photo by I. W. Krieg, 112 W. Fifth St., Cincinnati, O.

er "Island Queen," which had been chartered to carry them to Addyston. Instead of making directly for that place, the steamer carried the visitors up the river for some distance, affording a fine view of Cincinnati and the towns of Newport, Covington and Ludlow across the river.

The thermometer throughout the greatest part of the time during the convention kept hovering at an uncomfortable height and the refreshments with which the entertainment committee had stocked the boat were patronized and appreciated accordingly. After arriving at the works of the Addyston Pipe & Steel Co. the members scattered throughout the works, and inspected the many novel features found in this plant. Returning to the boat, a photograph of the visitors was procured, after which the return trip to the city began. During the homeward journey a fine luncheon was served.

EVENING SESSION.

E. H. Putnam read a paper on "The inspection of castings."

S. S. Knight, with the aid of lantern slides, illustrated the structure of steel as seen under the microscope, the different pictures being described in detail in his paper, "The micro-structure of iron and steel."

FRIDAY MORNING SESSION.

The last session of the convention was called to order Friday morning, when the paper contributed by H. M. Ramp on "Trolley systems, their value and cost," was read, and another by Stewart Johnson on "Steel Castings."

"Some notes on the Tropenas steel process" was read by Thos. Powell, of Powell & Colne, agents for the introduction of the process in the United States. Mr. Alexander Tropenas was also present and answered a number of inquiries made concerning the scope of the process.

Guy R. Johnson read his paper on "Manganese in cast iron," which produced a short discussion.

A paper by O. Benson, C. E., on "Combustible vs. Incombustible Foundry buildings," finished the list of technical papers.

ELECTION OF OFFICERS.

The only changes made in the personnel of the officers was the election of C. S. Bell to the presidency of the Association, in place of Francis Schumann, retired; C. L. Newcomb as vice-president for the New England states, replacing W. E. Sessions, retired, and C. A. Bauer as vice-president for the Central Western states, to fill the vacancy caused by the election of Mr. Bell to the presidency of the Association.

A vote of thanks was tendered Mr. Schumann for the ability with which he had guided the Association since its inception. A similar resolution was also tendered the Cincinnati foundrymen and others who had worked hard for the success of the meeting.

The following were registered as being present at the convention:

Francis Schumann, W. H. Pfahler, C. T. Holbrook, J. M. Warner, J. H. Pepper, Philadelphia, Pa.; Jos. T. Best, Montreal, P. Q.; I. W. Frank, J. S. Seaman, J. A. Logan, S. D. Sleeth, H. M. Wilson, J. S. McCormick, Phillip Mathes, Wm. Yagle, N. P. Hyndmant, John Dimling, R. G. G. Moldenke, E. M. Gross, J. C. Reed, Chas. Bailey, W. M. Singer, Eliot A. Kebler, E. Pitcairn, E. P. Botsford, Geo. Mesta, J. R. Moore, J. H. Shaffer, Geo. S. Caruthers, Pittsburg, Pa.; W. E. Sessions, Bristol, Conn.; E. H. Putnam, Atlanta, Ga.; C. S. Bell, C. E. Bell, Hillsboro, Ohio; Alva Carpenter, T. H. Colvin, R. Viall, E. J. Lyon, Providence, R. I.; P. W. Gates, B. T. Bacon, W. A. Jones, B. M. Gardner, Chris. J. Wolff, S. T. Johnston, G. W. Cope, W. C. Swift, E. S. Reid, G. W. De Smet, A. P. Ford, Geo. W. Getz, Chas. E. Hoyt, S. P. Hostler, B. R. Marchand, A. M. Thompson, D. Gallagher, C. W. Jackson, Chicago, Ill.; James R. Bowron, Charles Herron, Chattanooga, Tenn.; A. I. Findley, C. M. Miller, C. J. Langdon, S. S. Gaylord, J. A. Stone, T. H. Gartland, G. H. Palmer, V. T. Palmers, F. J. Patterson, Cleveland, Ohio; John A. Penton, B. Gomersall, John R. Russel, Henry Hansen, H. M. Leland, F. A. Goodrich, Thos. H. Simpson, J. D. Brennan, Geo. F. Crivel, Frank B. Ward, Detroit, Mich.; T. L. Griffith, John Hill, J. D. Smith, J. W. Fleig, F. S. Cadwell, H. F. Frohman, J. K. Pollock, W. T. White, Geo. McG. Morris, D. B. Meacham, W. C. Herron, John B. Morris, Charles Hoefinghoff, Chas. Klein, H. M. Lane, Fred J. Brunner, W. D. Patton, J. Stewart, W. A. Haven, C. J. Stewart, R. A. Suit, Louis G. Keck, W. P. Smith, E. F. Cook, R. Bahman, John A. Oberhelman, A. G. Wilson, Theo. Ballman, Daniel McLaren, S. E. Hilles, Chas. L. Miner, Wm. R. War-

ner, John E. Donovan, H. M. Norris, Chas. B. Erhart, A. S. Oberding, S. P. Bacon, J. Eckhardt, J. D. Burgess, J. D. Leary, Wm. Manley, J. W. Foley, Jr., Cornelius Cudee, Geo. M. Clark, A. W. Oseer, Wm. Buchanan, S. Bauer, S. P. Egan, Thos. Buchanan, C. E. Stewart, H. Beeching, Jas. H. Curan, Chas. Lange, Orville Simpson, A. J. Bauer, A. J. Wentworth, F. A. Klaine, E. H. Huenefeld, F. J. Spiekle, H. J. Gossiger, Otto Marmet, A. B. Trum, B. M. Meilzeiner, R. C. Nicholas, L. C. Rose, Geo. M. Hahn, A. H. Tuechter, F. A. Geier, J. J. Foley, F. Johannigman, R. J. Kroger, Charles Buchanan, Lincoln Haney, Wm. W. Herne, Louis F. Walter, A. Cunningham, Chas. S. Woodward, M. H. Fletcher, T. J. Joyce, John Sargeant, Sam H. Whittaker, W. L. Turner, Edwin McFarland, James A. Green, J. J. Bruce, C. A. Truesdale, E. Kemper, A. M. Smith, H. D. Erhart, Jay Gould, Geo. Webb, J. R. McFarland, F. P. Jones, C. H. Domhoff, J. W. Foley, Thompson Atkinson, H. C. Hoefinghoff, B. A. Wallingford, Andrew Hawthorne, Cincinnati, Ohio; Geo. B. Buckingham, Worcester, Mass.; L. S. Brown, Springfield, Mass.; J. S. Koons, Weatherly, Pa.; Geo. H. Lincoln, J. C. Alley, Victor Swenson, Boston, Mass.; J. F. Lanigan, Lawrence, Mass.; Stephen Holman, C. L. Newcomb, L. E. Bellows, Holyoke, Mass.; Jas. Flockhart, Edward Maher, Newark, N. J.; M. F. Moore, D. G. Moore, E. H. Mumford, Elizabeth, N. J.; John Kane, Ft. Wayne, Ind.; John F. Mills, Port Chester, N. Y.; I. J. Burger, Montpelier, Vt.; C. A. Sercomb, A. W. Bair, Milwaukee, Wis.; B. D. Northrup, Washington, Pa.; J. W. Treat, Hannibal, Mo.; L. D. Gilbert, O. T. Davis, Waynesboro, Pa.; J. P. Golden, Columbus, Ga.; P. E. Montanus, John G. Sadlier, M. L. Milligan, D. B. Hyde, S. S. Knight, J. D. Rodgers, F. M. Bookwalter, F. W. Bauer, Chas. L. Bauer, A. R. Ludlow, Springfield, Ohio; Henry Bond, E. W. Husted, Buffalo, N. Y.; Archer Brown, Thos. Powell, E. Robinson, New York, N. Y.; H. E. Morrill, Wm. Fischer, Andrew Macduff, Dave Smith, W. H. Kane, Charles E. Zimmerman, J. E. Zimmerman, Dayton, Ohio; Jas. S. Sterling, Robert C. Tolmie, Wilmington, Del.; F. D. Carney, Berlin, Germany; E. M. Drummond, Geo. C. Avery, Louisville, Ky.; Geo. R. Lombard, G. S. Lombard, Augusta, Ga.; W. Hein, Harvey, Ill.; Thos. D. West, Sharpsville, Pa.; R. C. Augur, Watertown, N. Y.; J. R. Homer, Galion, Ohio; W. W. Cheney, Jas. H. Tuttle, Manlius, N. Y.; W. H. Switzer, Little Falls, N. Y.; M. C. Ganley, J. T. Wilkin, Connersville, Ind.; C. H. Schwab, Rochester, N. Y.; F. E. Nulson, East St. Louis, Ill.; E. Edwards, Lynn, Mass.; F. E. Gordon, Conneaut, Ohio; Rudolph Wegelin, Bessemer, Ala.; W. A. Hall, S. Kahn, L. Kahn, H. Mashima, F. X. Black, Shelby Compton, H. P. Deuscher, Hamilton, Ohio; F. V. Knauss, Portsmouth, Ohio; A. F. Koons, Akron, Ohio; H. G. Byram, F. C. Schwoerer, O. T. Byram, Jos. Marsh, Indianapolis, Ind.; Wm. C. Doherty, Lowell, Mass.; Wm. Cureton, Mt. Vernon, Ohio; M. J. Pero, Fitchburg, Mass.; W. H. Orcutt, Noblesville, Ind.; A. L. Carleton, Hartford, Conn.; G. S. Campbell, Plainfield, N. J.; Wm. N. Gartside, Richmond, Ind.; Frank X. Lang, J. F. Dye, Henry Schuh, Newport, Ky.; D. T. Evans, Powellton, W. Va.; R. E. Mehan, R. F. Mehan, Monterey, Mexico; U. E. Kanavel, Zanesville, Ohio; C. A. Stevenson, St. Louis, Mo.; J. W. Gardner, Quincy, Ill.; C. R. Stephens, James Barclay, C. T. Morey, Moline, Ill.; Al. Cordingly, Denver, Colo.; John Grant, St. Paul, Minn.; H. L. Matthews, Decatur, Ill.; W. H. Wells, Lockport, N. Y.; J. E. Fisher, Oil City, Pa.; O. Traherne, Rockford, Ill.; Richard W. Boland, Birmingham, Ala.; J. P. Metcalf, Erie, Pa.; R. H. Frees, Walkerville, Ont.; C. A. Haertel, Waukesha, Wis.; P. S. Macgowan, Minneapolis, Minn.; H. L. Crane, Loveland, Ohio; H. B. Parker, Albion, Mich.; A. Tropenas, Paris, France.

Putting Up the Dough.

"Among the subscriptions made for a new armory at Pittsburg were $20,000 from the Carnegie Steel Co., Ltd., $10,000 from the H. C. Frick Coke Co., and $5,000 from Jones & Laughlins, Ltd."—(Exchange.)

(There is nothing out of the ordinary about this; those who dance ought to pay the fiddler.)

Old Timers.

In a recent review of Chicago's industries the "Chronicle" of that city says that in 1839 William and John Rankin established the first brass foundry, while Elihu Granger started an iron foundry as also did William H. Stow. P. W. Gates opened a machine shop, which is now known as the Gates Iron Works.

THE FOUNDRY

Published Monthly by

"The Foundry Publishing Co."

DETROIT, MICH.

JOHN A. PENTON - - - EDITOR AND MANAGER.
HENRY HANSEN - - - - ASSOCIATE EDITOR.

SUBSCRIPTION PRICE:

$1.00 a year in advance, postage prepaid in the United States, Canada and Mexico.

$1.75 a year to other countries, postage prepaid.

Single Copies, 15 Cents.

Advertising Rates are Printed in Each Issue, on Page Containing Alphabetical Index to Advertisers.

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Trade Outlook.

The situation in the iron trade may be judged from the following, taken from a recent market report of Rogers, Brown & Co.:

"It seemed eminently proper that the American Foundrymen's Association selected Cincinnati for their annual gathering, as this is the largest distributing point as to sales of pig iron and foundry supplies in the country. The week has been mostly occupied in entertaining the large and interesting convention, and yet the activity of the market has been such that unusual attention was demanded by business.

"There has been a fair run of orders embracing every variety of iron, and inquiries continue quite as numerous as ever.

"It is singular that, notwithstanding the enormous tonnage being handled, prices remain low and irregular, though many of the furnaces are so heavily sold ahead that on certain grades they are very firm.

"The continuance of the heavy demand must inevitably result in higher values, and with all the tonic influences at work to enlarge the trade, and promising outlook as to the future of the country's prosperity, all branches of trade seem hopeful of better prices.

"The iron market in the East is without any new features worthy of chronicle. Business in the large concerns runs up to the full limits, but some complaint is heard from the jobbing foundries of dullness incident to the summer season. Contracts for iron have been made pretty freely in the past and the deliveries are coming forward. The disruption of the Southern Association has had no bearing upon the market, as Southern irons run in price somewhat above Virginia and Lehigh Valley brands at most points of delivery.

"There is some sign of improvement in conditions for export trade, owing to the easing up of freight rates. It is very slight, however, and it is not expected that the export movement of pig iron will amount to much until the next cotton season begins.

"Both the output and the furnace stocks of pig iron are shown by last reports to be decreasing. Nearly all experienced observers are bulls on the general situation, but whether the improvement will begin in the summer or be deferred until fall will depend upon intervening events."

The Addyston Works.

The announcement from Cleveland, Ohio, that the Addyston Pipe & Steel Co. has offered to deliver pipe in the streets of that city for $14.93 possesses additional interest to many of our readers, who took advantage of their Cincinnati trip to inspect this plant.

The secret, if it can be called such, of the low cost of production reached by this company, must have been evident to every practical foundryman as laying largely in the perfect equipment with which the plant is provided, together with such a system of subdividing the labor as will enable each workman to turn out the greatest amount of work. The rapidity with which metal, flasks and castings were handled by powerful cranes must, to many, have offered a striking contrast to their own slow-going tools at home.

Although perfect appliances have rendered it possible to utilize cheaper labor, it should not be understood that the workmen engaged in this branch of the trade possess no experience or that new hands could be readily substituted and attain an equal efficiency. From the simplest walks in life men gain in experience with age and even a gang of common laborers, after years of service, have a greater value to a shop, although their work may be of the lowest kind.

Make These Things at Home.

Chicago is the best pig iron market the South has, north of the Ohio river. The enormous demand for castings, large and

small, makes a great call for Southern foundry grades, coke and charcoal. Our car wheel irons are largely sold there. But the largest demand on Southern furnaces for iron in Chicago is for the manufacture of malleable iron, a great deal of which is consumed by car builders, over the Northwest. Thousands of small malleable castings are required by the agricultural machine works. Southern sales of pig iron to Chicago foundrymen have rapidly increased of late. But what would be best for the South, would be the making of malleables in the South. Also cars and car wheels, and agricultural machines and tools, furnishing everything, iron, steel and wood, consumed in the manufactures mentioned. That way lies the highest prosperity for this section, and we are going that way, too. The pace, however, might safely be a trifle more rapid.—The Tradesman.

(The pace has been too rapid already, as the number of idle and abandoned car works throughout that section of the country testify. Whenever the time comes that malleable castings and cars can be made throughout the South in successful competition with the rest of the country, there will be no lack of capital. Capital is blind and does not recognize either sectionalism or politics, it goes wherever it feels half way confident of securing returns and the South will secure manufacturing industries in proportion to the amount of return it can guarantee on the capital invested. Many people are now nursing burnt fingers from trying to rake dollar chestnuts out of the fire in that section.—Ed.)

A Limit to Discussion.

Regret has been expressed in some quarters that a more extended discussion did not follow the reading of the majority of the papers presented at the late convention of the American Foundrymen's Association. It is a little singular that those who bemoan a lack of discussion did not avail themselves of the opportunity to "say something." Certainly, if anyone desired to be heard every chance was offered him to exercise his vocal organs, and no criticism on the disinclination of others to engage in oratorical contests should be offered by those who so zealously guarded their own "wordy" ammunition.

Looking at the matter more closely, no long search is required to find a reason for the limited discussion on some of the papers. Take, for instance, the one by Mr. Knight on the "Micro-Structure of Iron and Steel," and it will readily be seen that there were but few persons present who were sufficiently familiar with the subject to engage Mr. Knight in intelligent debate. The same could nearly as well be said with reference to the paper by Dr. Moldenke. Although the question the latter adopted for his topic is one that interests foundrymen more or less, it is nevertheless true that but few have given the subject more than the most superficial attention. Then there is the paper by Mr. Johnston on "Steel Castings," and how many of those present were sufficiently conversant with the peculiarities of steel founding to enter more deeply into the subject? We might continue throughout the list in the same manner.

In speaking this way, we are not questioning the intelligence of those who attended the convention. The papers read were largely educational, being taken from other than every-day foundry practice. It is not to be expected that a man is going to talk about something with which he is unfamiliar, especially where this would be readily detected. An overindulgence in "wind-jamming" such as has characterized some foundrymen's meetings, is neither dignified nor useful, neither does it yield the perpetrator any comfort. We rather admire the tact of a man who knows enough not to say anything unless he has got something to say.

It is the gift of but few to possess the ability to speak freely on the technical subjects which are brought before engineering societies and trades associations. A man may be able to write a convincing treatise on a question, and it is likely that he will make himself ridiculous, through contradictory statements, if he attempted to deliver the same in the form of a speech. Technical discussions are, and have always been, largely carried on through the technical press, where the author may be sure that his statements are presented in such a way as to convey his ideas and opinions. We feel confident that the discussion on the papers read at Cincinnati has not yet ended; in fact, we believe the best is yet to come, after mature thought and due deliberation.

While some of the different meetings of foundrymen may appear to have but a limited attendance, sight should not be lost of the fact, that through subsequent publication, the papers and the discussion following same are practically placed within the hands of every foundryman in the country; at least every practical and successful man.

In this way a much larger audience is ultimately reached and discussion extended beyond the actual meeting.

As We See It.

When electricity moved the first street car, a few years ago, enthusiastic electricians predicted that the new power would in a short time displace the steam locomotive; yet there are more of the latter in use to-day than ever, and the bulk of freight and passengers are handled by it. A European cupola, operated by a steam jet, appeared on the shores of America within the memory of the writer, and all fans and blowers were forthwith to be discarded, iron was to be melted at a much less cost than formerly, yet to-day we stick to the fan and blower, and many an enthusiast who planked his "spondulicks" on the steam jet cupola is giving vent to unprintable words, when asked about his connection therewith.

We are led into thinking this way by an article on the "Advance of Chemistry," by Mr. West, appearing elsewhere in this issue, which we print more in a spirit of fair play than for any original light it sheds upon the subject of chemistry in foundry practice. The regulation of mixtures by the measurement of shrinkage is far from being as old as founding itself, as fine measurements are of comparatively recent origin. Mr. West is apparently writing under the delusion that the average foundry makes a complete change to new brands or different shipments of iron every day, while, as a matter of fact, but a small change, if any, is made, and any deteriorating influence exerted by a new iron is counteracted and made of small consequence by the larger proportion of brands of iron whose quality is known.

"The more modern method 'analysis' to which we can resort to define what our iron is before it is charged," does not seem to have reached that state of perfection where it is absolutely to be trusted if we are to believe what Mr. West said in a recent paper contributed by him to the Pittsburg Foundrymen's Association and printed in THE FOUNDRY for May. Speaking of the differences in chemical analysis, the author said:

"When such a difference is to be found in analyzing pig metal, where the greatest care and skill have been exercised, what are the chances to be run in accepting analyses made by the different rapid methods in the rush of every-day furnace practice. Here we have, with the best of care and skill, a variation in the ingredients sufficient to affect two-thirds of all the castings made, causing them to be either bad or ill-suited for the use for which they were intended."

There is nothing that can harmonize the above and a number of other statements in the same article with the assertions of the author in the present issue. To cut the argument short, we may ask why, if chemistry is to prove such a money-maker for ALL shops, why has its introduction got to be forced? We believe there is room for both physical and chemical tests, but if chemistry alone can reduce the cost of production, say a dollar a ton, we can readily see that the fluctuating enthusiasm of our critic rests on a broad base, and we must acknowledge ourselves at a loss to understand why foundrymen have not more generally accepted his views. Because anything is modern, there is no reason to suppose that its use can with profit be extended universally; but if chemistry will pay in all foundries, it will get there without the aid of a brass band to push it along.

The Expense of Tools.

At the last meeting of the Western Foundrymen's Association one of the members made some remarks about the expense attached to operating such tools as movable grinders, pneumatic chipping tools, etc. It is one of the idiosyncrasies of the ordinary foundryman that things ought to last forever. Probably this is because he has been surrounded from infancy with a lot of appliances possessing extraordinary life. A cupola, if protected from the influence of rust, has about the same longevity as the elephant. The tools used by molders last in most cases too long for economy. A rammer is used until it is but little short of an ax, splitting the sand instead of packing it. A shovel is kept in use when it will not carry a quarter of the load it ought to. A pair of bellows is in service when it does not possess enough power to dislodge a fly from its roost. As foundrymen, we are more apt to use tools too long than not long enough.

As regards the expenses incurred in operating later-day appliances, they may be said to be regulated by the user. Some people will ride a bicycle for years, while others will have theirs in the scrap heap in three months. So individual management will decide the expense connected with the operation of tools placed in the foundry. Taking

it all around, we should take the same view of wearing out things in the foundry that the editor of a railroad journal did of wearing out car wheels. His argument was something like this: When car wheels are not worn out they are not earning anything: the sooner they are used up, the more money will be earned for the road. Let us all get away from the idea that it is bad management to have things wear out in the foundry.

The Micro-Structure of Iron and Steel.*

By S. S. KNIGHT.

Since systems of testing have become so numerous and so many are possessed of such seeming merit, engineers and constructors have been forced to pause a moment before closing the specifications that they are drawing up and give attention to what means shall be used to determine whether the purchased product shall have the desired properties.

It has long been felt, in the world of iron and steel manufacture, that the time-honored tests for fiber-stress, tensible strength, elongation under load and the determination of the elastic limit were not sufficient to insure the acquisition of material to meet special requirements, hence the foremost investigators turned with enthusiasm to the chemical laboratory as a means of supplementing the tests before mentioned. It is needless to add that even here they were somewhat disappointed as in the case of the carbon compounds of steel, the science of chemistry could not make a distinction between the ordinary cement carbon and that so familiarly known as hardening carbon. As an example, let us consider a steel rod which for convenience we will analyze and cut into two pieces. One part we will call A and the other B. The analysis showed that this rod contained .340 per cent. of carbon which, of course, was all combined, the phosphorus was .106 per cent. and the manganese .553 per cent. A was placed in a furnace and heated to a moderate redness or 700 degrees centigrade, while B was heated to about 1200 degrees. Both were thrown upon the ground and allowed to cool slowly. They were then taken and submitted to a strain of 45,000 pounds, each piece thus strained being eight inches long. The original diameter of the rod was nine-sixteenths of an inch. Under the stress A elongated .65" and B but .13", or one-fifth as much as A. A subsequent analysis showed that the carbon content had not changed, and the Eggertz method could make no distinction in regard to the compounds of this element with the iron in the two bars.

This case only shows how limited were the advantages to be derived from the possession of chemical facilities, and although they are of far more value at the present time than they were one year ago, yet the science has not been perfected to such an extent that its exponents need feel any alarming gratification when it comes to distinguishing between the various compounds of carbon and iron. Even if it were able to do this, it could only give us the composition of the material from a chemical standpoint, so that the discovery of what processes it was submitted to in its manufacture would still come under the domain of some other science. Hence engineers, who had so often found faulty steel of the correct chemical composition, but wholly lacking in those physical properties which had been so commonly found in similar stock, and which had been so particularly desired in the material in question, turned with a new zeal to the recently discovered process of determining the mechanical properties of steels by a system of mechanical analysis. It is this new departure with which we have to deal to-day, and which we shall proceed to investigate.

We have called this new method a system of mechanical analysis, and it may be interesting to know that this was the identical terminology used by its inventor, Dr. Sorby. The very name leads those interested to suppose that, like other mechanical and unlike chemical means of testing, this system would become popular since its name made the uninitiated to suppose that it was free from scientific terms. As usual, such was far from the case and the doctor's system of testing by reading or studying the fractures of metals with the naked eye or low power magnifying glasses soon grew into science with a terminology of its own, and in place of the simple magnifying glass came the compound microscope.

Let us note before going further that the difficulty of performimng a test will detract nothing from its intrinsic merit. It may,

* Paper read at the Cincinnati meeting of the American Foundrymen's Association.

however, and quite often will so limit its field of actual utility that ofttimes where it could be used to the best advantage it will be dispensed with solely because it is of such a nature that it is inconvenient to perform. This difficulty may arise from either of two causes or from a concurrence of both; first, the necessity of possessing costly apparatus, and second, the requirement of specific knowledge or obscure technique.

It is probable that no test has ever been devised in any class of work which possessed both of these difficulties in so marked a degree as that with which we have to deal in the present case.

To the unobserving it may have appeared that iron and more particularly steel is nearly homogeneous. Homogeneity is of two distinct kinds, which we may loosely call molecular and molar, or, more properly, chemical and mechanical. It must be kept in mind, however, that the presence of one in no way indicates or necessitates the presence or absence of the other. Thus two pieces of carbon might, in some manner, be held together, which hypothesis would necessarily make them chemically homogeneous, and yet one might be a brilliant, glittering diamond, while the other was but a shapeless lump of black graphite. In this case one would be crystalline and the other perfectly amorphous. Happily, however, for the investigator, this latter condition cannot exist among metals, since crystalline forces on one hand and strains of tension and compression on the other, superinduced by a dissimilarity of thermal conditions,

FIG. 1.
SERIES I, 2a—Annealed at 1015° C; Vertical Ill. x30; Carbon, .14 %.

FIG. 2.
SERIES I, 2c—Annealed at 1015° C; Vertical Ill. x200; Carbon, .14 %.

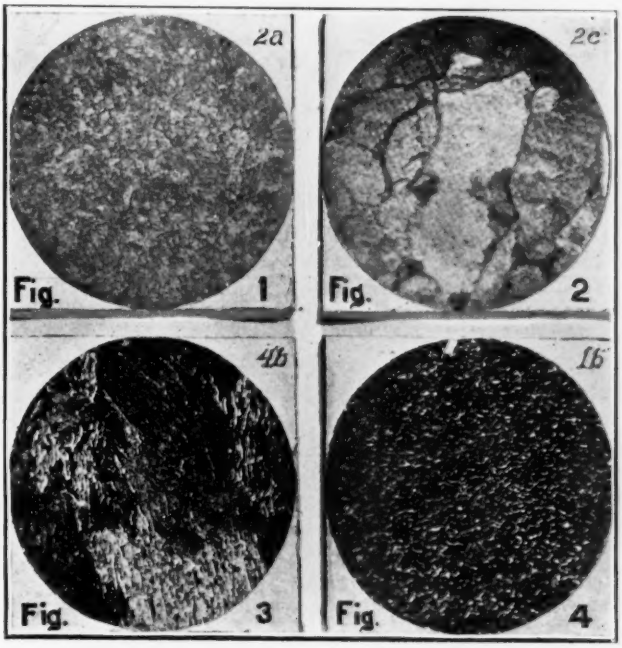


FIG. 3.
SERIES I, 4b—Annealed at 1370° C; Oblique Ill. x30; Carbon, .14%.

FIG. 4.
SERIES I, 1b—Hammered; Oblique Ill. x30; Carbon, .14%.

give rise to definite geometrical elements of physical constitution in every metal. According to Osmond, "these elements may, moreover, assume perfect crystalline forms, with their planes of cleavage well defined and highly distinct; or embryonic crystalline forms, segregated in the midst of a conglomeration of confused organization, which is the more common case, or pseudo-crystalline forms of expansion and contraction like those produced by the drying of gelatinous precipitates (as most frequently seen), all of these different forms associated.

You grasp at once the magnitude of the field to be covered by the science which uses the microscope in interpreting the surfaces and fractures of metals. In fact, the entire science of metallography has grown exclusively out of the study of fractures and the desire to correctly read them. The science is young, is but a thing of yesterday, and although we do not know what it embraces in its scope, nor can we predict what its future will be, yet we can say with absolute certainty what advantages may be obtained from its use to-day.

It is not necessary to consume your time with a history of this science; it will be sufficient to say that Dr. Sorby was its founder, and that under the influence of his writings and works it has grown to such an extent that where its originator was able to use but nine or ten diameters of magnifying power upon his specimens, the exponents of his system to-day can use upwards of one thousand diameters with excellent results. This rapid progress has been due, in a great measure, to the untiring efforts of Messrs. Martens, Osmond and a score or more of others. Like most sciences, it started in the laboratory, and has steadily grown and extended, until we find it used to-day as a supplement to chemical analysis and physical testing in every country upon the globe having large metallurgical interests.

We would not wish to assume the criterion of speaking for American metallurgists, but a quotation from Prof. Stillman, who is an acknowledged authority on all questions pertaining to engineering, will show in what high regard he holds this science. He says, in part: "Microscopic examinations of iron have led to remarkable developments of our knowledge of its structure," Recent investigations have shown that eminently practical results are to be obtained from microscopic examinations.

As an illustration of its commercial value, let a discovery made by one of the foremost German microscopists of to-day be considered.

Baron von Jupiter, while studying the deterioration of steel rails in actual service, found that before the complete annihilation of the structure obtained by heating and working took place, or coincident with it, that the end of the rail bolted between the fish plates would begin to show microscopic cracks or fissures. Further study of this phenomenon proved that the original structure could be restored by simply giving the rail proper thermal treatment. It will be understood that to accomplish this end no rolling or mechanical operation would be required, the proper degree of heat correctly applied fully attaining this end.

It had long been known that in iron in the refined state or as steel at least two mechanically different substances existed. These were supposed to be pure iron and iron in combination with carbon. This old theory was true enough for steels without temper or those that had never been subjected to heat treatment. As more attention was given to steel and its behavior under various conditions, some startling facts were discovered. As regards our present topic, it will be sufficient to note but two of these.

S. S. KNIGHT.

The first is that when any steel that is rich in carbon is slowly heated by any constant source of heat, the temperature rises uniformly or as the length of time that the heat is applied, until a point in low redness is reached (680° to 720° centigrade), when the material ceases to continue to uniformly increase in temperature and remains for an appreciable time the same color. After a time the temperature continues to rise uniformly again as if no disturbing influence had been felt. This it may do until liquifaction takes place, but usually lesser retardations occur as the temperature rises. In cooling the opposite phenomenon takes place, the color gradually leaving the steel until the same point is reached, when the metal assumes a sharp and distinct glow,

which soon subsides and the cooling continues in the previously described manner. These points where the retardations take place are called the W and V points by Howe, and are designated by Osmond as Ar, or in cooling the points of recalorescence.

Without entering too deeply into the character of this phenomenon, we may assume that the only retardation that takes place occurs at the W or V point, although as just shown, such is not the case. Osmond explained this phenomenon by asserting that the change which took place was from the ordinary iron to a special hypothetical, allotropic form, which change, of course, consumed heat, hence the retardation. As it was known that a sample quenched from a higher temperature than this point would be greatly hardened, Osmond gave this allotropic form of iron a property of increased hardness and claimed that the quenching did not allow a sufficient time for the iron in this hypothetical state to change back to iron in the ordinary state. It was also known that the increase in hardening, due to quenching, was roughly proportionate to the amount of carbon that the steel contained, but this was reconciled to this theory on the supposition that the carbon clogged the action or change from one form of iron to the other.

This same phenomenon explained from a microscopic examination would be very simple and, above all, would rely solely upon observed and known facts, instead of wholly upon an hypothesis that from its very nature could never be verified. The retardation would be seen to be due to the changing of composition which takes place in the carbon when it is subjected to a heat greater than 700° C.

The process of preparation for this examination would consist in making a button from the stock which is to be quenched and also one from the same material after it has undergone this operation. These buttons are sections of ⅛" thickness and any convenient diameter. After being turned out on a lathe they are mounted upon a glass slide such as is used for ordinary microscopic work and then placed in a chuck which securely holds them. The surface is

FIG. 5.
SERIES IV, 1b—Showing Cementite; x10; Blister Steel.

FIG. 6.
SERIES IV, 2b—Details of Cemtite; x60; Blister Steel.

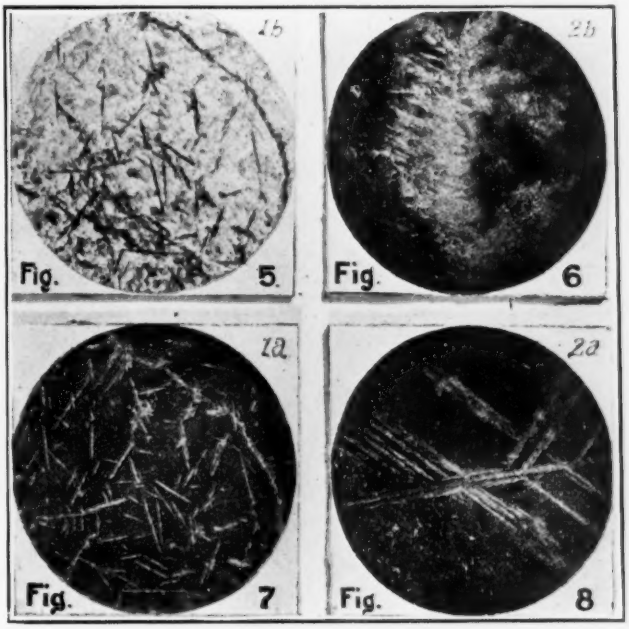


FIG. 7.
SERIES IV, 1a—Showing Cementite; x10; Blister Steel.

FIG. 8.
SERIES IV, 2a—Details of Cementite; x60; Blister Steel.

then ground off on an emery wheel, finer and finer wheels being used as the operation proceeds. The surface is then polished with emery flour, calcium carbonate, and lastly with washed rouge.

Under the microscope these buttons will show two entirely different structures. The first will show pure iron, which is known as ferrite, and some of the many compounds of iron and carbon. This ferrite may be seen nearly pure in malleable castings. When relief polished it retains a dull polish, but becomes massive as the process is continued; this appearance fades away and it becomes granular, sometimes resolving into the massive structure again under higher magnifications.

No. 1 shows the granular structure of ferrite and is a sample of .14% carbon steel which was annealed at 1015° C. No. 2 shows the massive structure above referred to under higher magnifications, the ferrite being in the form of large polyhedral crystals and the specimen being No. 1 magnified 66 times more than as shown before. The illumination in both cases was vertical. No. 3 shows the same steel annealed at 1300° C. under oblique illumination. The dark portions are those protected from the light by the irregularities of the surface. No. 4 is the same steel hammered, the illumination being also vertical. The granular structure is especially worthy of notice. This ferrite remains uncolored when etch polished with calcium carbonate or when etched with tincture of iodine.

Besides the ferrite just spoken of four other distinct forms are known to microscopists. All of these are in a greater or less extent compounds of carbon and iron. The most commonly seen of these is the variety known as cementite, which is supposed to be a carbide of iron of the formula Fe3C. It was formerly supposed to be the hardest of all the compounds of carbon and iron, having a hardness about equal to that of felspar. It is believed to be identical with the hard components of both cast and forged steels. Like ferrite, it remains uncolored when etched with tincture of iodine. The appearance of this constituent is often very deceptive, and its tendency to appear as scratches or fissures is likely to lead the neophyte astray. No. 5 shows a portion of a button of blister steel, which will at a glance show the appearance of which mention was just made. No. 6 shows a portion of the same field shown by its immediate predecessor, the magnifying power having been increased ten times. The detail of the supposed scratch is clearly shown, the illumination in both cases being vertical. It will be seen that the beginner would be apt to take the appearance just spoken of as an evidence of the incompletion of the polishing process. Such, however, is not the case and is a strong point in favor of the frequent inspection of the sample while being ground. No. 7 and No. 8 are also specimens of stock similar to No. 5 and No. 6, the cementite being shown in detail in the latter. It will be noted that what appeared as a cloud in No. 6 appears as distinct structure in No. 8. Also notice regularity of the various angles formed by the intersection of the monoclynic needles. In all of the last four specimens shown, the homogeneous structure of the ferrite or matrix in which the cementite lay, is a point worthy of attention.

Another of the compounds of iron and carbon has long been known as pearlyte, on account of its nacreous luster. When viewed with upward of five hundred diameters of magnifying power, under vertical illumination, this constituent may be resolved into flakes of hard and soft material lying in alternating lamillae or strata. Formerly this substance was divided into two kinds, known as granular and lamilar pearlyte. This terminology has entirely disappeared and in its place has come the word sorbite, in honor of Dr. Sorby, who, as will be remembered, was spoken of as the founder of this science. It has been clearly demonstrated that this sorbite is not of the formula Fe3C, as originally supposed, since when etch polished the color changes from yellow to light brown and then from blue to purple, and at no time as the change goes on is the color homogeneous. It has been suggested, and with reason, that this constituent may have the formula Fe10C.

Still another compound, which is of recent discovery, is termed Martensite, after the noted German microscopist, Prof. Martens. It is always present in iron that has been quenched from above the point of recalorescence, and requires etch polishing to bring out the structure, which is usually seen in the form of faccicles or collections of parallel rectilinear fibers. The matrix in which these fibers lie may be ferrite, containing a small amount of emulsified car-

bide of iron of uncertain composition or may appear to be intersected by short irregular lines. Osmond believes that what is now called martensite is not a definite compound of carbon and iron but rather an allotropic form of iron in crystalline arrangement, under the influence of carbon. This theory seems, however, strained to suit the one proposed by the same author in regard to the retardation in heating or cooling high carbon steels. This theory of crystalline arrangement finds some evidence in its support, from the fact that martensite is often seen as groups of fibers in bundles of three, running parallel with the sides of a triangle, as is the case in bodies which crystallize in the cubical system. Martensite may not always be identified by etch polishing, as sometimes it is not colored and then it takes but a light yellow sheen. Tincture of iodine causes it to take a yellow, light brown or black color, according to the carbon content of the steel being examined. It is partly on account of this irregular manner of receiving color that it is disputed whether it is a fundamental compound or not.

The last and in many cases the least known of all the microscopic constituents of steel is troostite, so called in honor of the noted French microscopist, Dr. Troost. This compound may be found in properly quenched medium iron, and if etch polished, nodules appear in relief together with strips or orientations of ferrite, while between these may be seen intercalations of moderate hardness and varying depth. These bands show temper colorations which produce an irregular spotted appearance not unlike the surface of a spotted marble. The strangest characteristic of this constituent is that it is almost amorphous, and sometimes slightly granular but never stratified.

Coming back to the peculiar behavior of steels and the facts that have been discovered in observing their deportment under various conditions, the peculiarity of recalorescence we have considered, the other of which mention was made is now before us.

The art of tempering steel has been known for centuries, but the nature of this process has not until recently been demonstrated.

FIG. 9.
SERIES II, 2a—Annealed at 750° C; Vertical Ill. x30; Carbon .45%.

FIG. 10.
SERIES II, 2c—Annealed at 750° C; Vertical Ill. x200; Carbon .45%.

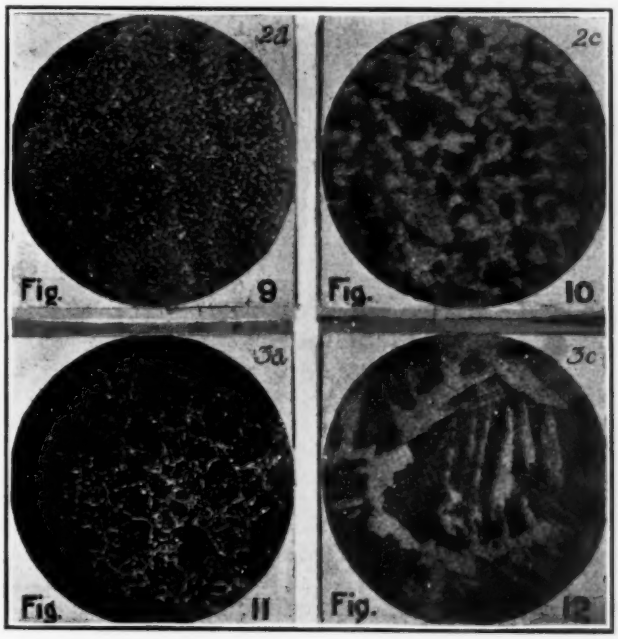


FIG. 11.
SERIES II, 3a—Annealed at 1115° C; Vertical Ill. x30; Carbon .45%.

FIG. 12.
SERIES II, 3c—Annealed at 1115° C; Vertical Ill. x200; Carbon .45%.

The fact that a bar of steel can be heated and cooled and by this process have its physical characteristics changed without altering its chemical composition seems in itself to be strong evidence that a change of no mean dimensions must have taken place in its structure. Before the utilization of the compound microscope it was impossible to obtain any definite knowledge concerning this change, but its use supplemented by careful chemical analysis has done much to unravel this mystery. It was formerly supposed that when a piece of tool steel was heated above moderate redness and quenched, that the sudden cooling in some manner made the molecules of iron come into closer contact, and hence so greatly augmented its density. This theory was, however, ridiculous, since the volume of any material thus treated was also increased. Microscopic examination showed that the real cause of hardness was the formation of a subcarbide of iron of the probable formula Fe24C. This compound decomposes in the presence of the most dilute acids into the normal carbide of iron and pure iron which appears under the microscope as ferrite. The subcarbide of iron possesses almost diamond-like hardness and also a great capacity for permanent magnetism. Its decomposition may be affected by annealing, and in such cases it is to be remembered that the temperature need not be higher than moderate redness as it has been found that this carbide is decomposed by a temperature of as low as 400° C. It is readily seen, from the above facts, how quenching may harden and annealing soften any steel which has a high carbon content.

Following this same phenomenon a little further, the above facts also constitute an explanation of why heating to dull redness will invariably destroy any permanent magnetism which a steel may possess. It is only necessary to keep in mind the capacity this carbide has for permanent magnetism and its low temperature of decomposition in order to have in hand all of the causes which are operative in bringing about this seemingly strange result.

While considering this form of carbon and iron combination, it will be apropos to spend a moment on another phenomenon commonly known as case-hardening. This process has been indiscriminately called a carbonizing or a phosphorizing one, according to whether the material to be case-hardened was packed in charcoal or bone-meal. As is well known, the depth or extent of this surface hardening is in proportion to the amount of time that the incandescent material is kept in contact with the packing, and also varies with the kind of filling used. The fact that is most worthy of our attention is that no hardening takes place until the material is quenched, and the higher the temperature at which this quenching occurs the harder will be the material thus treated. In order to determine if this process consisted in phosphorizing or carbonizing the stock, a bar of low carbon steel was cut into two pieces, one being retained as found and the other heated with the packing along with other work, being case-hardened for three successive days. At the expiration of this time a sample of each piece was taken into the laboratory and analyzed for carbon and phosphorus. The analysis showed the following results:

	Original Stock.	After being Case-hardened.
Phosphorus	.006%	.006%
Carbon	.0768%	.225%

In the original stock this carbon proved to be in the form of the ordinary carbide of iron (Fe3C), both from microscopic and chemical tests. The case-hardened piece was then heated and quenched until it was so hard that a file could scarcely cut it. An examination was made to ascertain in what state the carbon now existed and again both microscopic and chemical tests were made, with the result of proving beyond a doubt that the carbon had changed from the ordinary carbide form into the almost diamond-hard sub-carbide of iron of the formula Fe24C.

As mentioned before, one of the greatest advantages of using this system of microscopic investigation is the certainty with which the manner of working the stock may be told. Thus a sample of the steel rod which was spoken of could be sent to any part of the world and the microscopist making the examination would know that A had been subjected to a temperature suitable for the working of stock carrying .34% carbon, and that B had been heated to a temperature far in excess of this safe limit, and was no longer suited to the purpose for which A could be used.

While speaking of the manner of inspection which may be done with this instrument, some photomicrographs of steel of dif-

ferent carbon content will show how much of value may be learned by means of the microscope. No. 9 shows a sample of .45% carbon steel annealed at a temperature of 750° C. magnified only a small amount under vertical illumination. The granular appearance is to be noted as it disappears under a higher magnification. No. 10 shows this same specimen magnified 66 times more than No. 9. The ferrite now appears in large irregular flakes not so uniformly distributed as would be inferred from No. 9.

Coming now to heat treatment, we see in No. 15 a sample of tool steel containing 1.24% carbon which has been annealed at the high temperature of 1330° C. This steel shows the effect of this burning in the light piping ferrite, which is an infallible sign in any steel that it has been subjected to too high temperature.

No. 16 is another sample of this high carbon, this specimen being hammered. It is shown in oblique illuminations, the ferrite appearing as light flakes. No. 17 shows

FIG. 13.
SERIES II, 1a—Hammered; Vertical Ill. x30; Carbon .45%.

FIG. 14.
SERIES II, 1c—Hammered; Vertical Ill. x200; Carbon .45%.

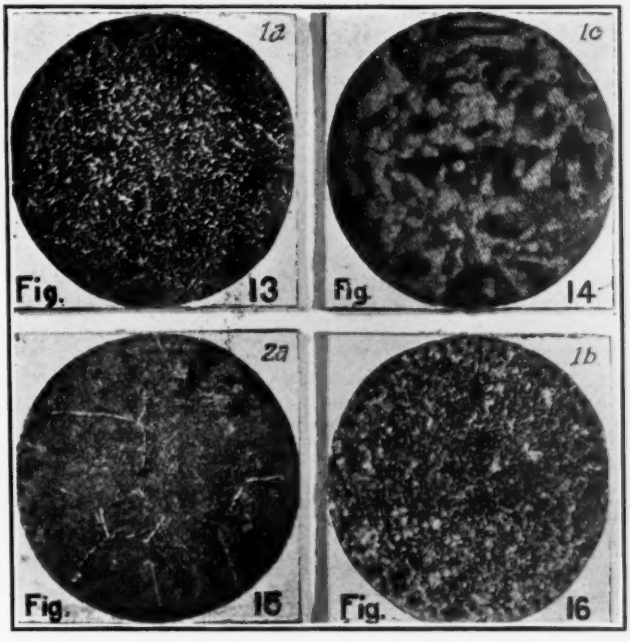


FIG. 15.
SERIES III, 2a—Annealed at 1330° C; Vertical Ill. x33; Carbon 1.24%. (Light piping ferrite; 1330° C; Burnt Steel.)

FIG. 16.
SERIES III, 1b—Hammered; Oblique Ill. x33; Carbon 1.24%.

Another sample of this same steel is shown in No. 11, this time the annealing having taken place from a higher temperature, 1115° C. In this case the ferrite is seen as ramified needles lying at all angles to each other. No. 12 is the same specimen under a magnification 66 times greater, the ferrite again appearing in irregular flakes. No. 13 and No. 14 are specimens of the same steel which have been subjected to treatment under the hammer, the ferrite showing as in the previous illustrations.

the other extreme of temperature for this same stock, it having been annealed at 1330° C. Here the ferrite again assumes its characteristic appearance in burnt steels, the illumination being also oblique.

We now come to No. 18, a sample of the same stock having been hammered. The ferrite seems to be more finely divided, and this conclusion is substantiated by the same specimen as seen under a magnification 66 times as great as shown in No. 19. Here the ferrite appears as a cloud, and this

structure always indicates a strong and uniform steel.

No. 20 shows a sample of steel containing .45% of carbon which has been subjected to a temperature too great for working. The ramifications of the ferrite are beautifully shown under vertical illumination, while in oblique illumination the structure appears less certain. No. 21.

Coming back to heat treatment and its effects upon steel in general, there is no more remarkable discovery that has been made in this field for many years than the explanation of the phenomenon of water-annealing. This heretofore inexplicable process is now accounted for in the most commonplace manner by means of the facts recently found out by the microscopic examination of iron.

If the end of a bar of iron be heated to a light redness and quenched in water, while the other end be left cold, it will be found that there is a place along the bar where the hardness is less than it was before the heating, although the end most highly heated be so hard that a file cannot cut it. It is now known that the increased hardness is imparted to the steel by the changing of the normal carbide of iron to the sub-carbide. This sub-carbide existed in small quantity in an emulsified form in the original bar, thus giving it what hardness it possessed. Now, as this sub-carbide decomposes at so low a temperature, there is a place in the bar where what little sub-carbide did originally exist, is changed into the normal carbide and thus the determination of that portion which will be water annealed. As the temperature rises this normal carbide would be retransformed into the sub-carbide, but as this rise at this point never takes place, the carbon is left in this intermediate form.

The use of the microscope in cast iron work will not be as easily demonstrated as in the case of steel, for in this case we have to deal with more fundamental forms, both of crystallization and chemical composition. The presence of one of these, graphitic carbon, greatly complicates the process and renders the microscopic examination of cast iron far from easy for the beginner. This in no way lessens or modifies the value to be received from its use but renders the possibility of its becoming popular less certain.

Possibly no character of work could afford a better example of the value of the adaptation of microscopic metallography to foundry work than a brief description of its use in the manufacture of the so-called gun-iron. As is well known, the only requirement of this metal is its high tensile strength, which should be over 30,000 pounds per square inch. Thinking that some other data would be of interest, a few other measurements have been made, which will be seen to be quite nearly allied to similar tests made upon the common iron used daily for ordinary castings. These bars were pulled and broken without any finishing of any kind, except No. 1 and 2, which were accurately turned down to size, the others being taken from the mold and rattled to clean off any adhering sand.

Tensile Tests.

No.	Meas'm'ts.	Brk. Str.	Meas'm't.
1	Area 1 sq. in.	34700	.563x.563"
2	Area 1 sq. in.	35400	.563x.563"
3	Area 1 sq. in.	33770	
4	Area 1 sq. in.	32430	

Transverse Tests.

Def.	Sh'k'g.	Brk. Str.	H'd'n's.
.100"	.140"	1500	237°
.080"	.145"	1490	236°

Shrinkage was measured on one lineal ft. Deflection was taken at 1000 pounds.

These bars show a shrinkage slightly in excess of that ordinarily seen in cast iron and a hardness slightly above that of material suited for common machine work. Bars No. 1 and No. 2 were pulled on an Olsen machine, while all other tests were made upon a Riehle machine except the hardness determinations, which were made upon Mr. Bauer's hardness tester.

In explanation of these results it must be remembered that all such metal is made of a small percentage of steel scrap, and that this material is low in carbon as compared with cast iron. But it must not be inferred that the consequent reduction of the carbon content, due to the addition of the steel accounts for the increased strength, for such is not the case. The combined carbon of cast iron does not exist in the same form as that which is found in the steel. Thus the carbon that exists as normal carbide of iron in pig-iron, which is both soft and weak, when melted with steel or light cast iron scrap in a cupola where

the metal comes into contact with the incandescent fuel, will be changed into one of the more complex forms of iron carbide, and may be identified as such under the microscope. It will thus be seen that in order

Silicon	.75% to 1.00%
Sulphur	.030% to .07%
Phosphorus	.250% to .300%
Manganese	.400%
Comb. Carbon	.750%
Graph. Carbon	2.000%

FIG. 17.

SERIES III, 2b — Annealed at 1330° C; Oblique Ill. x33; Carbon 1.24%. (1b and 2b—extreme variations due to heat; light ferrite.)

FIG. 18.

SERIES III, 1a—Hammered; Vertical Ill. x33; Carbon 1.24%.

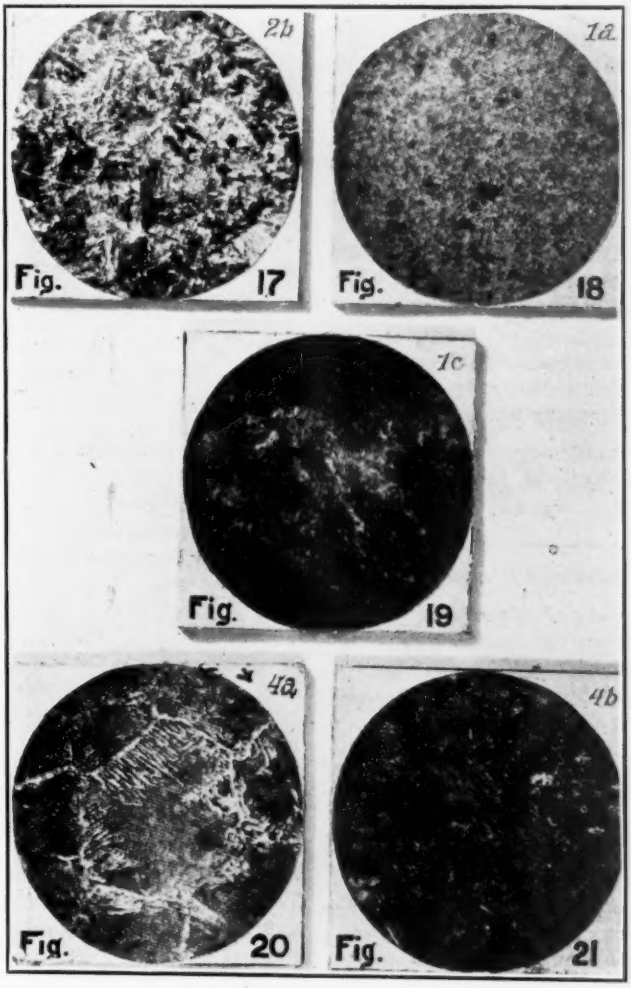


FIG. 19.

SERIES III, 1c—Hammered; Vertical Ill. x225; Carbon 1.24%.

FIG. 20.

SERIES II, 4a—Annealed at 1030° C; Vertical Ill. x30; Carbon .45%.

FIG. 21.

SERIES II, 4b—Annealed at 1330° C; Oblique Ill. x30; Carbon .45%.

to have an iron of exceptional tenacity it is only necessary to have a certain amount of these higher carbides of iron present, providing that the analysis of the metal is somewhat similar to the following:

If for any reason an iron should have such analysis and yet not have the desired strength, it is only necessary to examine it and see if the higher carbides of iron may be seen, and if so whether they appear to be

uniformly distributed throughout the mass. If not the mixer of such metal should at once take steps to bring about the increase in these carbides, which may be done in a number of ways.

And so examples might be brought ad infinitum showing the benefit which may be derived from the use of the microscope in the hands of a competent man. Want of time prohibits our going further into the investigation of this science at this time. The subject has necessarily been tedious to all who have not had at some time an opportunity to see for themselves the vast field which is open to study and improvement through the use of this instrument. However, it affords delight to me to be able to say that so much advancement has been made in such a comparatively short time. The science has an unlimited field before it, and it only remains to be seen how much benefit will be derived from its use in the future. It has been of this much value already that by its use we have been placed in possession of facts which explain phenomena which before appeared apparently without cause.

N. B.—All photomicrographs are from reprints of those made by M. Frances Osmond, of Paris, France.

Western Foundrymen's Association.

At the last meeting of this association discussion centered on the question of "The utility and efficiency of flexible shafting for use with grinders on heavy and intricate castings."

C. W. Shields, in a letter on the subject, took the position that compressed air offered a more econonomical power for operating movable grinders than flexible shafts, besides being available for a number of other purposes.

Frederick Schoff, of the Stow Flexible Shaft Co., gave it as his opinion that instead of compressed air displacing flexible shafts for the uses under consideration, it had actually increased the field for same. The chief drawback to flexible shafts had been the rope drive, which offered more or less chance for breakdowns, and had for that reason been discarded in favor of a motor operated by compressed air. Through this arrangement it is possible by the use of a universal joint to attach the shafting direct, thus doing away with rope drives and bearings of all kinds. The speaker thought that a movable grinder offered the best means for dressing any casting which is too large or heavy to handle on a stationary wheel. In reply to a question, he stated that it was not advisable to use shafting of longer than standard length, which is 8 feet, as a greater length not only added to the weight and cost but would also effect an increase in cost of repairs. Mr. Schoff cited several instances where flexible shafting is proving its utility, one concern having as many as a dozen flexible shafts in its foundry. This shop makes a specialty of hard iron castings for special work, and as this metal cannot be machined and the castings cannot be handled comfortably on the ordinary emery wheel, movable grinders have furnished the best methods of finishing these. Replying to a question, the speaker stated that flexible shafts were made with the view of being operated at as high a speed as calculated for the emery wheels, and that he had never known of a shaft breaking from an excess of speed. Regarding the handling of the shaft and grinder, he said it was like the handling of any other tool, largely a matter of experience upon the part of the man who operated it. Mr. Schoff advised the use of a wheel not more than six inches in diameter, as a larger one would only add weight and impede the progress of the operator instead of aiding him.

C. J. Wolff stated that his company had about fixteen flexible shafts in use at their works for grinding bath-tubs and other castings. They had been in use for quite a number of years with good success, being operated through a rope drive.

O. T. Stantial said the Illinois Malleable Iron Company considered the flexible shaft to be one of the most useful of tools, having found it to be particularly efficient in the dressing up of iron patterns.

Several of the members who attended the Cincinnati convention related some of the impressions received by them while in that city.

Unknown Greatness.

In perusing the latest catalogue from the S. Obermayer Co., of Cincinnati and Chicago, our attention was attracted to a number of new preparations, some of the claims for which we print below. An article advertised as "Star Steel Core Coating," has the following preface:

"The formation of smooth and approximately accurate holes in iron or brass castings always involves trouble and expense. The method proposed by us is to substitute when possible a little extra attention and labor in the foundry for the wear of machine tools, supplies, power and labor of the machine shop. Broadly speaking, the improvement suggested is to insert steel cores of the shape and size of the shaft or bar which the hole is to fit in the mold and afterwards remove them from the casting. This has been done in many foundries for years, but except for special work the objections of having to make tapering cores so that they may be removable and that the crystallization and chilling of the iron makes it difficult if not impossible to do any further work on a casting that cannot be brought to the emery wheel, have prevented the general use of steel cores.

"It will be admitted, however, that if these steel cores can be coated with a composition which will resist the heat and pressure of the melted iron, be non-conductive enough to prevent 'chilling,' so free from gas producing substances as to reduce the liability of 'blowing' to a minimum, of a nature not antagonistic to the iron, to which it will lay, hard enough when placed upon the steel cores to bear ordinary handling, and yet after the casting has been made, to become so soft as to offer no resistance to its removal, the use of steel cores is capable of a greater adaptation to modern foundry work than it has yet been given. It is not asserted that a steel core will work in all places. It cannot compete with a sand core for producing a hole that is good enough as made with the sand core without drilling or reaming. It has been found impracticable to cast a thin shell around a large steel core, but thinner shells can be cast around a steel core standing on end than lying down in the mold. A thinner shell can be cast around a well proportioned pattern that can be poured slowly than about one having thin webs."

Another article, for which a less tongue-twisting name might have answered as well, is "Ticeoleum," which is said to be the only effective preservative for keeping patterns in a perfect condition. The specific claims for this Latinized product, if true, are enough to cause any molder to be in love with it, though we are in doubt as to what it is that it won't allow to touch it, see fourth paragraph. Here are the claims:

"Ticeoleum won't gum up the patterns, especially the carved wood thereon.

Ticeoleum prevents sand or facing from sticking to the pattern when it is returned to the mold to be printed.

Ticeoleum won't allow the pattern to rust—in fact, it is the most effective rust killer

Ticeoleum won't allow anything of the kind to touch it, and experience has never met its equal.

Ticeoleum won't need heating, in short, it obviates the endless work of keeping patterns clean, as they will require but a little dusting with the molder's soft brush to keep them in good working order.

Considering quality and the service it renders, Ticeoleum ranks far above the realms of competition among so-called pattern dressings, hence its value as such is incomparable.

It is a new departure, and does not contain a particle of acid or beeswax.

When molding small or difficult pieces at drawing patterns Ticeoleum works like a charm, in fact, the molders who have tried and who are using this wonderful pattern dressing are in love with it.

Ticeoleum is just grand on Cannon and Oak Stove barrel or pot patterns.

Ticeoleum dries quickly on the pattern, leaving a hard surface like enamel, smooth as glass, and prevents anything from adhering to it.

The patterns don't pick up small particles of sand; consequently the surface of the castings whose molds are made with patterns dressed with Ticeoleum Pattern Dressing have a uniform and smooth surface. Patterns thus dressed will not corrode or rust even if not used for years.

Ticeoleum also prevents ground and polished metal from rusting."

Among appliances a "Patent Mounted Ladle," with which the molder is enabled to handle 200 lbs. of iron individually, has some claim to newness. The ladle is balanced on a two-wheeled truck, all jolting being absorbed by four springs. It can only be used for pouring molds that have the sprues or gates near the edge of the flask, and where the flasks are not over 16 inches deep. It is recommended for machine-made molds, and where large floors are to be poured off with very few hands.

The balance of the catalogue can be had from the S. Obermayer Co. for the asking. It contains much interesting reading, and we selected the few paragraphs above merely to show that the foundryman of to-day must read to keep posted.

Carrying the Joke Too Far.

How will I make a perfectly round ball solid upon the outside—no opening in the surface—of uniform thickness, hollow inside, free from all core sand and smooth—nothing but air inside? Such a ball will float in water. This may cause some of your readers to put their thinking caps on.

I can make the ball.—(Peter Griffin in Iron Molders' Journal for February.)

A word about the great air ball molder in February Journal and the tricky brother that can make it. I was not in a foundry more than a week before I was shown how it was done. Boys will be boys and men should be men. I have read some good articles on molding in the Journal, and hope to read many more, but of a character that will add to our knowledge as mechanics not as conjurers. What does it profit us to know how to make air balls?

Great Scott! Don't give us any more of this.

First you move your finger,
Then you move your thumb,
Then you pour the metal in,
Doodle, doodle dum.

—(James Williams in Iron Molders' Journal for March.)

Slow in Coming.

We hear much in these days of foundrymen's associations, of a desire to create a harmony of interest between employer and employed. All sorts of schemes are spoken of as a sure way to obviate the recurrence of strikes and to effect the peaceable settlement of differences that might arise, on paper. It is about time that some of this amicable disposition was displayed in the everyday business life of the subscribers to this doctrine. The iron trade has experienced a very material revival since the first of the year; in many places molders are in demand; but there is no spontaneous movement to let the molder share the long-looked for prosperity. A practical indication, in the shape of an advance in wages or an improvement of shop conditions, will make more converts among the molders than all the pretty speeches that can be conceived.—Iron Molders' Journal.

"Jacketing Up" a Foreman.

Doubtless every reader of this paper has at one time or another undergone the experience of being "jacketed up" for shortcomings, real or supposed. Too often the punishment of a "good talking to" is administered in public, and results in somebody being fired for resenting the amusement which he is furnishing his shopmates. Some foremen hold the theory that chastising a molder before a full house leaves a greater impression all around, while others think an earnest, private conversation produces the best results. We are inclined to believe that the latter are right.

"Jacketing up" a foreman is generally done in the private office of the manager, and sometimes the latter receives the worst of the interview. Some ingenuity is occasionally displayed in "reading the riot act," and the following system, adopted by the senior member of a large foundry, has in it such a degree of premeditated cruelty and lack of respect for a man's feelings that it is worthy of a wider notice:

For three or four days this man will have all castings with the least defect put to one side when they will be artistically arranged with the defective part out of sight, and an order sent to the foreman that he is wanted by the senior member. The latter smiles and good-nature beams out everywhere as he says to the foreman:

"Getting along fine in the foundry, are you not?"

The foreman, taking this as a sort of a compliment, with a vision of increased pay appearing on the horizon, acknowledges that he is getting along fairly well.

"Fine castings, ain't they?" says the senior member, as he gives every evidence of being well pleased with the way things are going.

"They do look first rate," assents the foreman.

"They do, hey?" and here the smile of the senior member vanishes, something after the manner of Dr. Jekyll and Mr. Hyde. Picking up one of the castings and turning the defective part towards the foreman, he transforms his whole behavior into that of a fiend, who gloats over the misery he has wrought, and as he throws the casting as far as his strength will permit he roars out:

"Good castings, hey! —— —— —— —— —— —— ——. Any damphool from Oshkosh could make better castings than that!"

The effect of this sudden change upon the foreman can be better imagined than described. There is only one disadvantage to this method of administering a rebuke in a sarcastic manner, and that is that it won't work twice on the same man.

The Pennsylvania Thermal Test for Car Wheels.

The object of the thermal test for car wheels is to reproduce as nearly as possible the heating action due to the application of the brakes. The Pennsylvania thermal test is as follows:

"Wheel laid flange down in the sand, and channel-way 1½ inches wide and 4 inches deep, molded with green sand around the wheel. The tread of wheel must form one side of this and the flange part of the bottom. Channel-way filled to the top with molten cast iron. Two minutes later an ex-

THE PENNSYLVANIA THERMAL TEST FOR CAR WHEELS.

amination of plates to be made. Wheel to be accepted must not be broken in pieces, and cracks, if any, must not extend through tread."

The illustration appearing herewith will give the reader some idea of how this test is carried out. It is reproduced from a pamphlet recently issued by the New York Car Wheel Works, of Buffalo, N. Y., describing some tests made by them on a special grade of chilled wheels.

This company made experiments along this line four or five years ago, the results of which were that the nearest approach to the gradual heating action of the brake could be obtained by casting half an inch of metal around the face of the wheel.

The objection to the Pennsylvania test as it is now made is that a band of metal an inch and a half in diameter and from five to six inches deep at a temperature of say 2,600 degrees is cast against the cold tread of the wheel and allowed to remain two minutes and the interval is too short for the heat to penetrate any distance into the plates.

As is well known, when the brakes are applied, the wheel being perfectly cold, it takes a definite interval of time before the wheel becomes heated to anything like the temperature that it does in the Pennsylvania thermal test and in that interval of time the heat has had an opportunity of penetrating the wheel sometimes as far even as the hub.

The New York Car Wheel Co. made experiments to find out what would most nearly reproduce this gradual heating action by placing small cones of wax at varying distances from the rim of the wheel on the plates and noting how long it took them to melt and they found with the Pennsylvania test, as it is now made, that the cone of wax one inch from the tread melted suddenly, but at the end of two minutes the one two inches away had barely begun to melt, the others showing no change whatever.

The result, therefore, of the test as it is now made, is that the wheel is subjected to a very much more severe strain than it would ever be called upon to stand in service.

This test is unusually severe, as the expansion strains imposed on the wheel involves an enlargement of its diameter of at least ⅜ of an inch over all. That it is possible to make chilled wheels to successfully withstand this strain of expansion and contraction is most important.

In the case of a steel-tired wheel, under similar test, an expansion of ⅜ of an inch would shear the bolts fastening the tire to the body of the wheel.

If it is necessary to have car wheels made to withstand such strains, it would seem prohibitory to the use of the steel-tired wheel.

In the wheel illustrated, which is a 33-inch, 560-lb. wheel, Pennsylvania Railroad standard, it took 40 seconds to pour the molten iron and after two minutes the wheel was taken from the sand for examination. No failure of any kind developed, the only result being a slight skin fracture in the front plate of wheel, ⅛ inch deep and 4 inches long. Wheel was broken under the Master Car Builders' drop (standing 13 blows), but there was no sign of crack where the skin fracture showed. The brackets showed no crack. Chill ½ inch and ⅝ inch.

Hydrofluoric Acid.

Will some readers of THE FOUNDRY kindly furnish instructions as to the use of hydrofluoric acid for cleaning castings? We would especially like to know its cost as compared with sulphuric acid when used for the same purpose.

W. A. MACHINE CO.

Flexible Pattern Lumber.

One of our subscribers writes us for the address of some firm supplying "flexible pattern lumber," and as we do not know of same we ask our readers to inform us on the subject.

Drying Cores With Steam.

Can ordinary cores be successfully dried by steam? C. O.

The P. H. & F. M. Roots Co., of Connersville, Ind., have just issued a new catalogue of Positive Pressure Blowers and Pumps. It differs from the ordinary run of trade catalogues in that it is short and to the point, without wearying the reader with empirical formulas of which he knows nothing, and yet giving the necessary information concerning capacity, speed, horse power and weight.

CAST IRON NOTES.

Devoted to Inquiries from Practical Foundrymen on the subject of Melting and using Cast Iron. Address all Inquiries to W. J. KEEP, care of The Foundry.

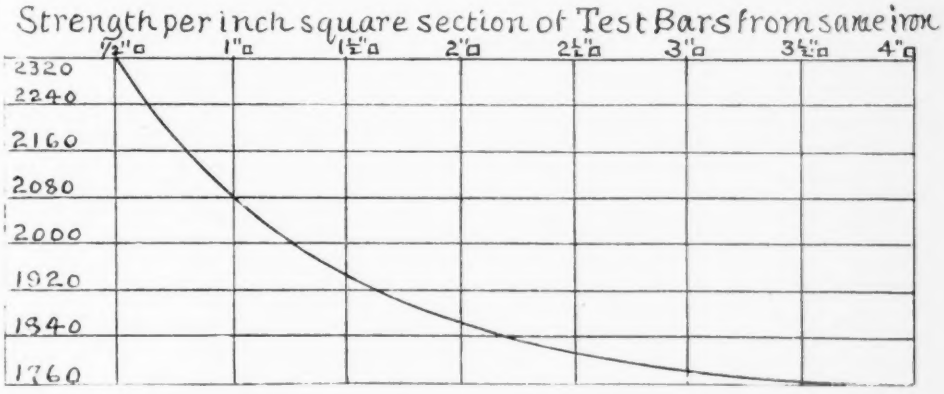
DIFFERENT SIZES OF CASTINGS MADE FROM THE SAME IRON.

Several remarks during the discussion of papers at the Foundrymen's Convention suggest comment. One was "Don't make your test bar too small, if you don't know what sort of a test bar the inspector is going to make."

From one ladle of iron that would make good machinery castings, pour test bars ½ inch square and 12 inches long, and 1 inch, 1½ inches, 2 inches, 3 inches and 4 inches square each 24 inches long.

Find the transverse strength and by ordinary formula find the strength of a section of each bar 1 inch square by 12 inches long, and we shall find 2,320, 2,080, 1,944, 1,860, 1,780, 1,760 pounds. The ½ inch square bar is 240 pounds stronger per inch square section than a 1 inch square bar, and a 4 inch square bar cast from the same iron is 320 pounds weaker per 1 inch square section. If you make a 1 inch square bar and the inspector asks for a bar 1½ inches square from the same iron, it would be 136 pounds weaker per 1 inch square section.

If we represent these values graphically we have a curve as shown in diagram.



It is evident from the foregoing that the only way to find the strength of a casting by means of a test bar is to make the test bar the same size of the casting. How then can we adopt any one size of test bar as a standard, to be used by all, and that will indicate the strength of all castings made from that iron.

Evidently we cannot adopt one size and then figure another size by the ordinary formula, because the formula would make the strength of a four inch square bar the same proportional strength as the 1 inch square bar, while it is really much weaker.

When we have a strength curve giving the relative strength of all sizes of test bars from the same iron, if we can improve the mixture so as to make the 1 inch square bar 2,280 pounds we can add 200 pounds to the strength of each size, and the strength of a 1 inch square section of the 4 inch bar would be 1,960 pounds.

Mr. Knight said that in his practice the 1 inch square section of a test bar 1½ inches square was only 200 pounds weaker than the same section of a ½ inch square bar, which speaks in the highest terms of his skill in making mixtures. In ordinary shops there would be a greater variation than is shown by the above curve.

The reason that a large casting is weaker than a small casting from the same iron is that its slower cooling causes the grain to be coarser.

It will never be possible to select one size of test bar as standard until a curve is selected by which from the strength of such a standard bar, the correct strength of any size of test bar can be determined. No mathematical formula can be constructed that will correctly give the strength. The graphic method is the only method and it is simple and rapid. With it, it is not important what size of bar shall be selected. It must be large enough to give a gray grain. For high chilling iron a ½ inch square bar will run white and is of no use whatever, but iron

suitable for machinery castings will run gray in a bar as small as ½ inch square.

HOW TO SAMPLE IRON FOR ANALYSIS.

Mr. Frank brought up one of the most important points that has been presented. He said that at Lucy Furnace it was found that shot iron chilled by dropping molten iron in water, and less than ¼ inch diameter, gave best results for chemical analysis; and represented the composition of the whole cast better than drillings taken from a pig. Segregation was prevented by the sudden cooling, and all the elements are evenly diffused.

Even in a test bar 1 inch square there is time for the chemical elements to concentrate in patches. Mr. Colby, in The Iron Age of April 21, suggests that drillings for analysis should be taken from small castings, because there is less segregation than in large castings. I mentioned in Cast Iron Notes for June, that all of the drillings taken from the sample should be used in making chemical determinations because the non-magnetic particles will not be picked up by the magnet. One of the first things to do in standardizing test methods, is to adopt a standard method of taking drillings, including the size of casting that will most nearly give the composition by avoiding segregation. Until this is done we must not expect different chemists to be able to find the same percentages, even if drillings are all taken from the same hole in a pig of iron. The elements are so unevenly distributed on account of segregation that the different chips from a drill do not have the same chemical composition.

I have made many efforts to have a ½ inch square test bar cast from the iron that runs into the various parts of the pig bed.

The shrinkage of this test bar would indicate an approximation of the silicon and in such a small casting the segregation would be minimum. Drillings from such a bar would represent the composition nearly as accurately as the shot iron at Lucy furnace. If it was stated that the analysis was made from drillings taken from this small test bar and the shrinkage and depth of chill was given it would show the exact character of the pig iron. It would at once standardize analyses.

An iron that will not run gray in a test bar ½ inch square will not make soft machinery castings.

I do not advocate the use of a ½ inch square test bar for giving the actual strength of large castings, but to show the character of the iron. It should run gray and the shrinkage gives a very near approximation of the influence of the chemical composition on the physical character, and also tells if more or less silicon is needed in a casting. It tells how much scrap it will carry.

My opinion is that the best bars for a standard for strength would be a test bar ½ inch square and another 1 inch square, cast in the same mold from one gate and well separated from each other, the ½ inch bar to be used for shrinkage and chill. The strength of the two will give two points on the strength curve.

A test bar larger than ½ inch square is so influenced by slow cooling that it does not show the influence of the chemical composition as well as a bar that will not allow the chemical elements to segregate.

Drillings for analysis should be taken from the ½ inch bar to avoid the segregation which occurs in large bars.

Another remark was as follows: "A friend of mine used a ½ inch bar as representative of castings he was making. Analysis showed the carbon in it to be all in the combined state; heaven only knows what became of the free carbon." The iron may have been exactly suited for very heavy castings, but the fact that a ½ inch bar ran white showed that more silicon was needed for small castings. The test bar shows that the iron is not at all suitable for light machinery castings. Iron that will contain considerable free carbon if put into very heavy castings will have it all in the combined form in small castings. The speaker thought that only heaven could know what became of the free carbon that was apparent in the large casting, but any chemist could tell him.

Convention Rumblings.

S. T. Johnston got there.

John G. Sadlier managed to keep cool.

T. L. Griffith and John Hill are a matched team.

Cope! Speech! Cope! Speech—Cope spoke.

Mr. J. S. McCormick gave away a neat souvenir.

Bacon—Pickands, Brown & Co.—head of the class.

C. T. Holbrook was there—everybody knows the rest.

Lots of people met J. P. Goldca. His address is Columbus, Ga.

"Jones, of Chicago," had the reputation of covering the most ground.

D. B. Meacham was everywhere, looking after the comfort of others.

That was a neat little adv. that the Obermayer Co. gave their friends.

E. H. Putnam generally holds a good hand when it comes to a "showdown."

Col. Warner, of Philadelphia, couldn't resist the temptation to come west this year.

The Safety Emery Wheel Works' souvenir was a top made to sail away among the clouds.

Joseph T. Best crossed the Canadian frontier again this year to renew old acquaintanceship.

J. T. Wilkin is understood to be laboring under the impression that the sun never sets in Cincinnati.

James A. Green knows more about entertaining a crowd than his youthful appearance would indicate.

C. A. Sercomb. No use of starting in to tell of this gentleman's tribulations. Too much for a monthly paper.

Are chemists in demand? Well, it looked so from the crowds that surrounded Dr. Moldenke and Mr. Knight.

Mr. P. W. Gates may be a new-comer at these Conventions, but Chicago could not have sent a more worthy representative.

If Lazard Kahn will keep on following up the Foundrymen's conventions, he will soon rival Dr. Depew as an after dinner speaker.

Al Cordingly was the only representative from the wild and woolly west, but then he made up for half a dozen ordinary persons.

The Cleveland Facing Mill Co. had a supply of their Perfection core boxes on hand to convince the foundrymen of their merit.

George W. Cope, "Iron Age"; A. I. Findley, and B. M. Gardner, "Iron Trade Review," looked after the interests of their respective papers.

Nobody can accuse L. S. Brown of having talked business in Cincinnati. Not a word did we hear him say about charcoal facing.

T. H. Colvin, of the Colvin Foundry Co., of Providence, R. I., enjoyed himself every minute, and will be a constant attendant hereafter.

C. S. Bell deserved his promotion to the presidency of the Association. The members of same know a good man when they see him.

Although a busy man, H. F. Frohman found time to pilot a number of the guests out to the largest foundry supply house in the world.

If Thomas D. West ever forgot hard work, chemical analyses, and everything else connected with the foundry business, it was on the return trip from Addyston.

The Pittsburg delegation, representing members of the Pittsburg Foundrymen's Association, made their influence in a quiet way felt upon several occasions.

Everybody forgave Mr. James R. Bowron for having been born abroad, and voted him to be as good an American as can be found even in these patriotic times.

The Brown & Sharpe Co. always take considerable interest in the American Foundrymen's Association, and Mr. R. Viall and Mr. E. J. Lyon can be relied upon to attend.

Mr. E. H. Putnam has, in his quiet way, made a large circle of friends, and his contributions in the way of papers have always been greatly appreciated, and are very valuable.

Mr. W. H. Pfahler, in his quiet, logical, and convincing manner, made many friends for the National Founders' Association, of which he will always be regarded as practically the father.

The Entertainment Committee did most nobly, and a few residents of the Queen City were especially conspicuous for their energy in endeavoring to promote the pleasure of the visitors.

J. D. Smith was handicapped by a pair of crutches, but then he had the right kind of stuff in his parlor to draw a large attendance; at least, it is not known that he suffered for company.

Past President sounds odd in connection with Mr. Schumann's name. However, he has been in harness long enough to earn a rest, although he will be expected to show up promptly at future meetings of the Foundrymen.

Mr. I. W. Frank can feel a sense of personal pride as a result of his efforts to take the next Convention to Pittsburg. It is the first time a formal invitation of that character has ever been presented upon the floor of the Convention.

J. F. Lanigan, the same fellow, from forty miles east of Boston, propounded a few new questions this year again. They have not been answered so far. Those people who know all about the foundry business will please take notice.

The Whiting Foundry Equipment Co. showed the Avery Molding Machine in operation. The novel features of this machine were fully decribed in our January issue. The machine on exhibition was arranged for the molding of sash weights.

While the Convention of 1898 was not in some respects as largely attended as the previous one, the amount of good, substantial work done, the character of the papers read, and the earnestness of the discussions were superior to any previous year.

The Convention was disappointed at the enforced absence of Mr. C. A. Bauer—that is to say, it was before it made the acquaintance of his son, "C. L.," who read his father's paper, and explained the working of the machine to the satisfaction of everybody.

The bottles of compound, automatic, self-acting, hydro-dynamic, magnetic, electro-Mexican tangle-foot with which a certain gentleman treated his friends on the third floor of the Grand Hotel won't be forgotten in a long time by a few of those who took his word for it and believed it "harmless."

Francis Schumann, First President Philadelphia Foundrymen's Association, and re-elected twice; first President of the American Foundrymen's Association, and re-elected once—could any man wish for more than that? And yet it is a matter of record that each position was accepted by him reluctantly.

Another thing: Are there any foundrymen in America who are more highly respected by a wide circle than is the retiring president of the American Foundrymen's Association? If so, where are they?

When the announcement was made by the Nominating Committee that Mr. C. S. Bell was their choice for President, no one was more surprised than that gentleman himself—in fact, he nearly fainted. It seemed to strike everyone else, though, as about the proper thing, and all seemed glad to congratulate him.

The Marmet-Smith Coal & Coke Co. exhibited a pyramid of Connellsville coke. Although genuine Connellsville, this coke possesses the distinction of being manufactured outside of that region, being made at North Bend, Ohio, of coal from the Connellsville district, transported on barges down the Monongahela and Ohio rivers.

Conventions are, of course, more or less all alike—all but this one. Howard Evans was detained at home through ill-health, and everybody connected with the Convention had to explain his absence fifty times a day. Probably the presence of no one man connected with the American Foundrymen's Association would be missed so much.

A large number of the delegates availed themselves of a cordial invitation extended by the Niles Tool Works, at Hamilton, Ohio, only a few miles away. The party went to Hamilton on an early morning train, spent the bulk of the day at the works, where a lunch was served by the company, and returned to Cincinnati in the afternoon.

The speech of Mr. James R. Bowron, Vice-President of the Tennessee Coal, Iron & R. R. Co., was one of the great features of the meeting, and will long be remembered by those who heard it. More than all else it was valuable and instructive to those present in formulating a good idea of the practically inexhaustible resources of the Southern iron interests and Southern prospects.

There will never be a complete or perfect meeting of the American Foundrymen's Association without Mr. George B. Buckingham of the Arcade Malleable Iron Co., at Worcester, Mass., and also L. S. Brown, of the Springfield Facing Company of Springfield, Mass. Everybody, however, does not have to send a report home endorsed by a number of friends as a sort of certificate of good conduct, as one of these gentlemen did.

The W. E. Sessions Foundry, at Bristol, is one of the most modern, complete, and perfectly equipped plants on earth, but for all that, Mr. W. E. Sessions finds it incumbent upon him to make the trip to the Convention each year and rub up against foundrymen from all parts of the country.

At the same time it might just be mentioned that visitors to the Sessions works are always welcome, and are cordially conducted throughout the whole plant.

The Buffalo Forge Co., of Buffalo, N. Y., are mailing one of their semi-annual publications "A Modern Blacksmith Shop," to the trade.

Among the Foundries.

P. C. Hubbard's foundry at Lynchburg, Va., burned June 2.

Stock & Mathews will erect a new foundry at Cambridge, Ohio.

Heintz Bros., of Portland, Oregon, are erecting a new foundry.

The El Paso (Texas) Foundry & Machine Co. is erecting a new plant.

The foundry of J. T. Caulkins, at Thornville, Mich., burned recently.

Snead & Co.'s foundry, at Louisville, Ky., was destroyed by fire June 23.

Caldwell & Johnson have leased the Snead foundry at Toledo, Ohio.

J. F. Lanfersieck & Co., of New Bremen, Ohio, are erecting a foundry.

The Madison (Wis.) foundry, owned by Theo. Kupfer, burned recently.

The Stanton (Mich.) Novelty Works is erecting an addition to its foundry.

The foundry at Waterloo, Ia., operated by Thos. Cascaden, Jr., burned June 3.

The Moltby Hot Air Furnace Co. is erecting a foundry at Coldwater, Mich.

The Tecumseh Malleable Iron Company has been incorporated at Tecumseh, Mich.

The foundry of P. C. Hubbard, at Lynchburg, Va., was burned June 2. Loss, $8,000.

The Ramapo Iron Works, of Hillburn, N. Y., are building an addition to their foundry.

Godfrey, Rebman & Co., of Philadelphia, are increasing the capacity of their foundry.

At Oronogo, Mo., the Oronogo Foundry is about completed and equipment is being installed.

The brass foundry of E. J. Welch & Co., at Fitchburg, Mass., was destroyed by fire May 27.

J. A. Record, of Livermore Falls, Maine, is making several alterations and additions to his plant.

The foundry and iron works of H. C. Gregg & Co., at Trumansburg, N. Y., was burned June 18.

The Earl & Wilson Company of Gastonia, N. C., has been incorporated to do a general foundry business.

The Martin-Muir Co. has been incorporated to carry on a general foundry business at Nevada City, Calif.

The new addition to the foundry department of the Chester Steel Casting Co., at Chester, Pa., will be rushed through and the building will be ready for occupancy in a short time.

The Oregon Iron Fence & Foundry Co. has been incorporated at Portland, Ore., by A. Walker, R. Huffschmidt, and D. McCarty.

Howe & Beard, of Canandaigua, N. Y., have dissolved partnership and the business will hereafter be conducted by Mr. Howe.

The Brass Foundry operated by John Powers, at 438 East 10th street, New York City, was damaged to the extent of $1,000 by a fire June 18.

The firm of Haight & Clark, iron and brass founders, Albany, N. Y., have been dissolved. S. J. Haight retires from the concern, he having sold his entire interest to his partner, John W. Clark.

The erection and machine shops of the Watsontown (Pa.) Car Manufacturing Co. were burned to the ground May 30. The plant has not been in operation for eight years. Loss, $60,000; insurance, $37,000.

The Whitin Machine Company, of Whitinsville, Mass., have just completed a new casting shop which will be entirely fireproof. It is furnished by The Berlin Iron Bridge Company, of East Berlin, Conn.

The foundry of the Connersville Blower Co., at Connersville, Ind., was totally destroyed by fire June 3. This will not interfere with the filling of orders, as arrangements have been made to temporarily obtain castings elsewhere, until a new shop can be erected.

The gray iron foundry of the old Champion Machine Co. and the malleable foundry of the late Champion Malleable Iron Co., of Springfield, Ohio, after being closed for five years, have been re-opened under a new management with Wm. N Whiteley as general manager. Mr. Ben Howell has charge of both places.

The Londonderry Iron Company, of Londonderry, Nova Scotia, C. A. Meissner, General Manager, have contracted for about 1,000 tons of the 12 in. and 24 in. pipe which the National Foundry & Pipe Co., of Scottdale, Pa., obtained from the City of St. John. The balance of the order will be filled from Scottdale.

The title to the property of the former Power City Foundry & Machine Company, at Niagara Falls, N. Y., has been purchased by Messrs. F. R. and A. W. French, and hereafter they will conduct the business under the new firm name of Niagara Engineering Works. They will do a general foundry and machine business as well as designing and manufacturing.

NOTICE!

Advertisements in this column, 30 cents a line for each insertion About seven words make a line. The Cash and Copy should be sent to reach us not later than the 20th to insure publication.

Answers addressed to our care will be forwarded.

TO SUBSCRIBERS

whose names appear on our **subscription** list, we will give one free insertion under this heading to those in want of positions, the advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

WANTED.—Addresses of foundries that can furnish us columns, lintels, etc., at bed rock prices and inspective quality. Beckwith & Reeves, 290 Broadway, N. Y.

WANTED.—To lease small foundry and machine shop. Capable of making castings up to 8 tons. Must be a good shipping point, and in running order. Address "C. H.," Box 141, care THE FOUNDRY.

WANTED.—Foreman for annealing department of a malleable iron company. Must thoroughly understand the annealing and cleaning of malleable iron castings. Address "Malleable," Box 140, care THE FOUNDRY.

POSITION wanted as superintendent of malleable iron foundry. Have had a large experience and can produce a sperior malleable steel. Best of references furnished. Address "Malleable Superintendent," Box 146, care THE FOUNDRY.

WANTED.—Situation as brass foundry foreman; 12 years practical experience upon locomotive machinery and general jobbing work. Good reference as to character and ability. Address "J. C.," 62 Johnston Ave., Kearny, N. J.

WANTED.—Position by foreman pattern-maker; age 39; 8 years as foreman; thoroughly competent to run first-class shop; skilled in mill, mining, pumping and general machinery. Best references. Address "Pattermaker," care THE FOUNDRY.

WANTED—Situation as brass foundry foreman. Have had twelve years' experience on both light and heavy castings and can come well recommended as to my ability in mixing metals and handling men. Address, "BRASS," Box 97, care THE FOUNDRY.

WANTED—A sober and industrious molder would like to correspond with parties contemplating a change in their foreman, with a view of taking charge of same. Southern California preferred. Can give the best of references. Address W. H., Box 145, THE FOUNDRY.

WANTED.—A bright young molder to assume position of foundry foreman, must be accustomed to make light and heavy machine castings in green sand. The place will demand much hard work and study, and only an energetic and ambitious man will suit or need apply. Address "Foreman," Box 143, care THE FOUNDRY.

FOUNDRY FOREMAN WANTED.—A sober, industrious mechanic, wanted by Stove Co. in Indiana. A foreman that knows how to mold good castings, and will see good castings are turned out, and can handle men to good advantage. State if married, your age, salary wanted, and reference you can furnish. Address "Central," Box 142, care THE FOUNDRY.

WANTED.—A man as superintendent of a steel foundry who is thoroughly familiar with the manufacturing of steel castings. It is not essential that he is familiar with the running of a furnace or the melting of steel, but he must have a general knowledge of the business which will enable him to show good management. Address "Steel," Box 139, care THE FOUNDRY.

Personal.

Mr. Jeff Lewellyn, for the past three years foreman of the Wickham & Chapman Co.'s foundry, of Springfield, Ohio, has retired.

Martin E. Hershey, late manager of the Harrisburg Foundry and Machine Works, at Harrisburg, Pa., has accepted a position with the Maryland Steel Company, at Sparrow's Point, Md.

A. L. Carleton, formerly with the Pratt & Whiting Co., Hartford, Conn., has accepted the position of superintendent of the steel foundry operated by the Benj. Atha & Illingworth Co., at Newark, N. J.

The Cincinnati Corrugating Co., of Piqua, Ohio, have issued a catalogue of the numerous varieties of roofing material made by them.